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# Nuclear Science Abstracts

## NEW NUCLEAR DATA
## 1953 CUMULATION

Vol. 7 No. 24B
Dec. 31, 1953

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INTRODUCTION TO

# NUCLEAR SCIENCE ABSTRACTS

A Publication of the United States Atomic Energy Commission Technical Information Service

The printing of this publication has been approved by
The Director of the Bureau of the Budget August 2, 1951

Nuclear Science Abstracts is issued twice a month throughout the calendar year by the Atomic Energy Commission. It is intended primarily to serve scientists and engineers working within the Atomic Energy Project by abstracting as completely and as promptly as possible the literature of nuclear science and engineering. It covers not only the unclassified and declassified research reports of the Atomic Energy Commission and its contractors, but also material in its field of interest which appears in technical and scientific journals and unpublished research reports of government agencies, universities, and industrial research establishments.

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# NEW NUCLEAR DATA

A summary of New Nuclear Data on Half-Lives, Radiations, Relative Isotopic Abundances, Nuclear Moments, Neutron Cross Sections, Reaction Energies, and Masses.

The new nuclear data presented here have been prepared by the Nuclear Data Group which has been reorganized under the sponsorship of the National Research Council with the support and cooperation of the National Bureau of Standards.

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In this issue Nuclear Science Abstracts presents its second annual cumulation of new nuclear data. The material collected here is that which has appeared in the literature from about October 1952 to October 1953. The earlier parts have already been published in the quarterly cumulations, 6B(March 31), 12B(June 30), and 18B(September 30). A complete list of journals covered will be found on the following page.

The quarterly lists will be continued in 1954 with the new feature that each list will contain all previous 1954 data as well as the current quarter's material. It will then not be necessary to search through previous quarterly collections in order to find all the 1954 results for a given nucleus.

The data which are collected in the NSA lists are put on 3″ × 5″ cards as the papers are abstracted. A limited number of sets of these cards could be supplied promptly, possibly monthly, to laboratories or individuals on a cost basis, if the demand warrants. Those interested in subscribing for these cards, should write to the Nuclear Data Group, National Research Council, 2101 Constitution Avenue, N. W., Washington 25, D. C.

## ABBREVIATIONS

| | | | |
|---|---|---|---|
| a | absorption measurement | b | coefficient in angular correlation function, $1 + b \cos^2 \theta$ |
| $a\beta\gamma$ | absorption of $\beta$'s in coincidence with $\gamma$'s | B | band spectra method |
| ace⁻ | absorption of conversion electrons | Be$\gamma$n | measurement by detection of photoneutrons from Be |
| a coin | measurement by placing absorbers between counters in coincidence | $\beta\gamma(\theta)$ | angular correlation of $\beta$'s and $\gamma$'s in coincidence |
| $\alpha$ | total $\gamma$-ray conversion coefficient, $N_e/N_\gamma$ | Calc | calculated value from experimental work reported elsewhere |
| $\alpha_K, \alpha_L, \ldots$ | $\gamma$-ray conversion coefficient for electrons ejected from the K,L,... shell | cc | cloud chamber |
| | | ce⁻ | conversion electrons |
| $\alpha_0, \alpha_1, \ldots$ | $\alpha$ to g.s., first excited state, ... of residual nucleus | chem | chemical separation of product following reaction |

| | |
|---|---|
| Cpt | Compton electrons |
| d | (1) deuteron, (2) descendant of, (3) days, when used as superscript |
| d,p($\theta$) | angular distribution of protons with respect to deuteron beam |
| D$\gamma$n,D$\gamma$p | measurement by detection of photoneutrons or photoprotons from deuterium |
| $\overline{E}$ | average energy |
| $E_0$ | resonance energy |
| $E_\beta$,$E_\gamma$,... | energy of $\beta$ ray, energy of $\gamma$ ray,... |
| $E_{dis}$ | disintegration energy |
| EA | electrostatic analyzer |
| E1,E2,... | electric dipole, electric quadrupole,... |
| $\epsilon$ | electron capture |
| $\epsilon_K$,$\epsilon_L$ | electron capture from K, L shell |
| f | fission, in abbreviations for methods of production or detection |
| F-K | Fermi-Kurie $\beta$ energy distribution plot |
| $\gamma(\theta,T)$ | numbers of $\gamma$'s as function of angle and temperature |
| $\gamma\gamma$,$\beta\gamma$, $\alpha\gamma$,n$\gamma$ | $\gamma\gamma$,$\beta\gamma$, $\alpha\gamma$, or n$\gamma$ coincidences. (0.123 $\gamma$) (0.246 $\gamma$, 0.325$\gamma$) means 0.123 $\gamma$ in coincidence with 0.246 $\gamma$ and 0.325 $\gamma$ |
| $\Gamma$ | resonance half-width (the whole width at half-maximum) |
| G-M | Geiger-Müller counter |
| g.s. | ground state |
| I | (1) nuclear induction magnetic resonance method; (2) spin in units h/2$\pi$. + or − signs after spin values denote even or odd parity of state in question |
| ic | ionization chamber |
| IT | isomeric transition |
| J | quantum state of compound nucleus in a nuclear reaction. "I" is used to denote the spin of the target nucleus, final nucleus |
| K/L | $\alpha_K/\alpha_L$ |
| $l$ | angular momentum of particle absorbed into nucleus |
| M | molecular or atomic beam resonance method |
| M1,M2,... | magnetic dipole, magnetic quadrupole... |
| mb | millibarns |
| Mic | microwave method |
| mir | measurement by total reflection of neutron beam from mirror surface |
| ms | mass spectrometer |
| $\mu$ | (1) magnetic moment in units of nuclear magnetons, (2) micron, $10^{-4}$ cm |
| $\mu$s | microseconds |
| osc | pile oscillator method |
| p | (1) proton, (2) predecessor of |
| para | paramagnetic resonance method |
| parentheses | parentheses are put around values which are given for identification purposes |
| pc | proportional counter |
| $pe^-$ | photoelectrons |
| ppl | photoplates or emulsions |
| primes | primes indicate inelastically scattered particles |
| q | electric quadrupole moment in units of barns |
| quad res | quadrupole resonance method |
| Q | reaction energy in Mev |
| s | (1) spectrometer method, (2) seconds, when used as superscript |
| S | atomic spectra measurement |
| scin | scintillation counter |
| 2 cryst scin s | 2-crystal scintillation spectrometer |
| sl | lens spectrometer |
| sl;$ce^-$ | conversion electrons measured in lens spectrometer |
| st | strong |
| s$\pi$ | 180° spectrometer |
| s$\pi\sqrt{2}$ | double focusing spectrometer |
| $\sigma$ | cross section in barns |
| $\sigma_0$ | cross section at resonance energy, $E_0$ |
| $\sigma_a$ | absorption cross section |
| $\sigma_{el}$ | elastic scattering cross section |
| $\sigma_{in}$ | inelastic scattering cross cross section |
| $\sigma_s$ | scattering cross section |
| $\sigma_t$ | total cross section |
| t | triton, $H^3$ |
| T | (1) isotopic spin; (2) temperature |
| $\tau$ | half life in units indicated |
| $\tau_1$,$\tau_2$ | half life of upper, lower state |

| | |
|---|---|
| $\tau_{\beta\beta}$, $\tau_{\epsilon\epsilon}$ | half life for double $\beta$, double $\epsilon$ decay |
| th | thermal |
| w,vw | weak, very weak |
| % | % of disintegrations |
| † | relative numbers. When used in connection with $\gamma$ rays, relative numbers of photons, not photons plus conversion electrons, are meant |
| +, − | even, odd parity when used in connection with level properties |

Standard journal abbreviations are used.

All energies are given in Mev and all cross sections in barns unless otherwise stated in the tabular material.

## MAGNETIC MOMENT STANDARDS

In order to have a consistent basis for recording data on magnetic moments, results have been based on the following values and are without diamagnetic corrections.

$\mu(H^1) = 2.7934$ nuclear magnetons
This value has been adopted arbitrarily because it is the one used as a base in the Table of H. L. Poss, The Properties of Atomic Nuclei, I. Spins, Magnetic Moments. (Revised, BNL-26 (T-10), (unclassified).) The values reported in the New Nuclear Data summaries are thus directly comparable with those listed in the survey of Poss.

| | |
|---|---|
| $\nu(Na^{23})/\nu(H^1) = 0.26450$ | E. Bleuler, M. Gabriel, Helv. Phys. Acta 20, 67(1947). |
| $\nu(D)/\nu(H^1) = 0.153506$ | F. Bloch, E. C. Levinthal, M. E. Pachard, Phys. Rev. 72, 1125 (1947). |
| $\nu(B^{11})/\nu(H^1) = 0.320827$ | D. A. Anderson, Phys. Rev. 76, 434(1949). |

## LIST OF JOURNALS SURVEYED FOR NSA 7

Acta Phys. Acad. Sci. Hung. 1(1952); 2(1953); 3, No. 1(1953).

Acta Phys. Austriaca 6, Nos. 2-4(1952); 7, 1-3 (1953).

Acta Phys. Polon. 11(1951-1953); 12, Nos. 1-2 (1953).

Anales real soc. españ. fis. y quim. 48, Nos. 9-12(1952); 49, 1-8(1953).

Ann. Phys. 7, May-Dec. (1952); 8, Jan.-June (1953).

Ann. Physik 11(1952); 12, (1953).

Arkiv Fysik 4, Nos. 5-6; 5(1952); 6, 1-4(1953).

Australian J. Phys. 6, Nos. 1-2(1953).

Australian J. Sci. Res. 5, Nos. 3-4(1952).

Bull. Research Council Israel 1, Nos. 1-4 (1951); 2, 1-3(1953).

Can J. Chem. 30, Nos. 11-12(1952); 31, 1-9 (1953).

Can. J. Phys. 30, Nos. 5-6(1952); 31, 1-6(1953).

Compt. rend. 235, Nos. 15-25(1952); 236; 237, 1-13(1953).

Czechoslov. J. Phys. 1, Nos. 1-2(1952).

Doklady Akad. Nauk SSSR 83, Nos. 4-6; 84-86(1952); 87-89; 90, Nos. 1-5(1953).

Experientia 8, Nos. 11-12(1952); 9, 1-9(1953).

Helv. Phys. Acta 25, Nos. 5-7(1952); 26, 1-5 (1953).

Indian J. Phys. 26, Nos. 7-12(1952); 27, 1-3 (1953).

Izvest. Acad. Nauk. Ser. Fiz. SSSR 15, (1951); 16, (1952).

J. Am. Chem. Soc. 74, Nos. 20-24(1952); 75, 1-18(1953).

J. Chem. Phys. 20, Nos. 11-12(1952); 21, 1-9 (1953).

J. de Chim. Phys. 49, Nos. 11-12(1952); 50, 1-8(1953).

J. Franklin Inst. 254, Nos. 5-6(1952); 255; 256, 1-3(1953).

J. Phys. Chem. 55(1951); 56(1952); 57, Nos. 1-6(1953).

J. Phys. radium 13, Nos. 5-12(1952); 14, 1-9 (1953).

J. Phys. Soc., Japan 7, No. 6(1952); 8, 1-4 (1953).

J. Research Nat. Bur. Standards 49, Nos. 5-6 (1952); 50; 51, 1-2(1953).

Koninkl. Ned. Akad. Wetenschap. Ser. B 46-55 (1946-1952); 56, Nos. 1-3(1953).

Kgl. Danske Videnskab. Selskab, Mat-fys. Medd. 27, Nos. 7-16(1952); 28, 1 (1953).

Nature 170, Nos. 4326-4339(1952); 171; 172, 4366-4378(1953).

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Phil. Mag. 43, Nos. 343-347(1952); 44, 348-356 (1953).

Physica 18, Nos. 8-12(1952); 19, 1-8(1953).

Phys. Rev. 88(1952); 89-91(1953).

Proc. Phys. Soc., (London) 65A, Nos. 392-396 (1952); 66A, 397-405(1953); 66B, 397-405 (1953).

Proc. Roy. Soc., (London) 215A(1952); 216A-219A(1953).

Rev. fac. sci. univ. Istanbul 10-17(1945-1952); 18, Nos. 1-3(1953).

Rev. Mexicana Fis. 1(1952); 2, Nos. 1-3(1953).

Sitzber. Akad. Wiss. Wien, Math-naturv. Kl. IIa 159(1950); 160(1951); 161, Nos. 1-6(1953).

Trans. Chalmers Univ. Technol. Gothenburg Nos. 1-130(1941-1953).

Zhur. Eksptl'i Teoret. Fiz. 22, Nos. 2-6; 23, 1-5(1952).

Z. Naturf. 7a, Nos. 9-12(1952); 8a, 1-8(1953).

Z. Phys. 132, Nos. 4-5; 133(1952); 134; 135, 1-4(1953).

# NEW NUCLEAR DATA

$H^2_{1\ 1}$

$\mu$ 0.857608 I

$\mu(D)\ /(H^1)=0.307012192\pm0.000000015$ $H^1H^2$

T.F.Wimett, Phys. Rev. 91,499A(1953).

Capture $\gamma$ $H^1(n,\gamma)$ $E_n$= th scin

2.23

No lower energy $\gamma$'s observed

A.Bracci, U.Facchini, A.Malvicini, Phys. Rev. 90, 162(1953); Nuovo Cim. 10,949(1953).

$H^3_{1\ 2}$

$\beta^-$ 0.0180 log ft = 3.008 s

Neutrino mass <0.250 kev

F-K plot straight down to 5.5 kev

L.W.Langer, R.D.Moffat, Phys. Rev. 88, 169A and 689(1952).

$He^3_{2\ 1}$

I 1/2 M

G.Weinrich, V.W.Hughes, Phys. Rev. 90,377A(1953).

$He^4_{2\ 2}$

$H^3(p,n)He^3$ $E_p$ = 1 to 5

Broad max. at ~3 long counter

p,n($\theta$) indicates $l_n$=1 predominant

H.B.Willard, J.K.Bair, J.D.Kington, Phys. Rev. 90,865(1953).

Capture $\gamma$ $H^3(p,\gamma)$ $E_p$= 0.80

20.3 scin

J.B.Warren, G.M.Griffiths, Phys. Rev. 92, 1084A (1953).

$H^3(p,\gamma)$ $E_p$=1 to 5.2

No resonance for production of ~20-Mev $\gamma$'s

Yield curve flattens at $E_p$~3.5 scin

H.B.Willard, J.K.Bair, J.D.Kington, Phys. Rev. 90, 865,(1953).

$H^3(p,\gamma)$ $E_p$= 1 to 4.3

No resonance for production of ~20-Mev $\gamma$'s

$\gamma$ yield curve still rising at $E_p$= 4.3

J.E.Perry, Jr., S.J.Bame, Jr., Phys. Rev. 90,380A (1953).

$H^3(p,\gamma)$ $E_p$= 3 to 7.3

No resonance for production of ~20-Mev $\gamma$'s

$\gamma$ yield curve still rising at $E_p$= 7.3

R.W.Birge, J.Jungerman, UCRL-2109(1953).

$He^4_{2\ 2}$

$H^3(d,n)$ $E_d$= 0.20 ppl

No level between 1 and 13 Mev ($\sigma/\sigma_{g.s}$<~.015)

L.Rosen, Nucleonics 11, No. 8,38(1953).

$He^3(d,p)$ $E_d$ = 10.2 ppl

No level below 20.9 Mev ($d\sigma/d\Omega$ for excited state <0.2 mb/sterad. at 90° lab.)

J.C.Allred, Phys. Rev. 84, 695(1951).

$He^4(p,p')$ $E_p$ = 32 pc

No level below 23.3 Mev ($d\sigma/d\Omega$ for low energy p group <0.1 mb/sterad. at 45° c.m.)

J.Benveniste, B.Cork, Phys. Rev. 89, 422(1953).

$He^5_{2\ 3}$

Levels $H^3(He^3,p)$ $E_{He^3}$ = 0.30 scin

g.s. group observed at $E_p$ = 9.05

No other p group found

W.M.Good, W.E.Kunz, C.D.Moak, ORNL-1415(1952).

Levels $He^4(n,n)He^4$ $E_n$ = 4.14 ic

n,$He^4(\theta)$ g.s. $p_{3/2}$

1.76 $p_{1/2}$

P.Huber, E.Baldinger, Helv. Phys. Acta 25, 435 (1952).

Levels $Li^7(d,\alpha)$ $E_d$ = 0.98 ppl

g.s. $\Gamma$ = 0.3

2.5 $\Gamma$ = 1.5

P.Cüer, J.J.Jung, Compt. rend. 236,1252(1953).

Level $H^3(d,n)He^4$ $E_n$=0.01 to 1.73 pc

16.65 J = 3/2 +

$\sigma_{max}$ = 5.1 ± 0.1 for $E_d$ = 0.109

J.P.Conner, T.W.Bonner, J.R.Smith, Phys. Rev. 88, 468(1952).

Level $H^3(d,n)He^4$ $E_d$ = 0.015 to 0.125

16.64

$\sigma_{max}$ = 4.95 for $E_d$ = 0.107

E.J. Stovall, Jr., W.R.Arnold, J.A.Phillips, G.A. Sawyer, J.L.Tuck, Phys. Rev. 88, 159A(1952).

Level $H^2(t,n)He^4$ $E_t$ = 0.08 to 1.2

t,n($\theta$) 16.65 J = 3/2 + long counter

$\sigma_{max}$ = 4.0 ± 0.5 for $E_t$ = 0.185

H.V.Argo, R.F.Taschek, H.M.Agnew, A.Hemmendinger, W.T.Leland, Phys. Rev. 87, 612(1952).

$He^6_{2\ 4}$

$\tau$ 0.83$^s$ pc

$Li^6(n,p)$ $Li^7(n,d)$ $Be(n,\alpha)$

M.E.Battat, F.L.Ribe, Phys. Rev. 88, 159A (1952); 88, 156(1952).

**$He^6_2$** $\tau$ **0.84$^s$** $Be^9(n,\alpha)$

G.Vendryes, Ann. Phys. 7, 655(1952).

$(\beta)(Li^6)(\theta)$, $Li^6$ time of flight spectra, suggest $\beta$-neutrino angular correlation of tensor interaction

J.S.Allen, W.K.Jentschke, Phys. Rev. 89,902A (1953).

$(\beta)(Li^6)(\theta)$ indicates tensor predominates over axial vector interaction No$\gamma$(<3%)

B.M.Rustad, S.L.Ruby, Phys. Rev. 89,880(1953).

**$Li^5_3$** Level $He^3(d,p)He^4$ $E_d$=0.26 to 3.6
16.80 J = 3/2 + scin
$\sigma_{max}$= 0.90 for $E_d$= 0.43

J.L.Yarnell, R.H.Lovberg, W.R.Stratton, Phys. Rev. 90,292(1953).

Level $He^3(d,p)He^4$ $E_d$=0.19 to 1.60 pc
16.78 J = 3/2 +
$\sigma_{max}$ = 0.69 for $E_d$ = 0.400

T.W.Bonner, J.P.Conner, A.B.Lillie, Phys. Rev 88, 473(1952).

**$Li^6_3$** Level $Be^9(p,\alpha\gamma)$ $E_p$= 2.565 s $pe^-$
$\gamma$ 3.57 M1 $e^+$spectrum

R.J.Mackin, Jr., Phys. Rev. 92, 1084A(1953).

No 3.58 level by $Li^6(d,d')$ $E_d$ = 7.70 s$\pi$
3.58 level was observed by $Li^6(p,p')$

C.P.Browne, C.K.Bockelman, W.W.Buechner, A.Sperduto, Phys. Rev. 90,340A(1953).

No reaction $Li^6(\gamma,d)He^4$
$\sigma$ < ~6 x $10^{-6}$ for $E_\gamma$ = 2.76, ~7, 17.6
Isotopic spin forbidden*

*A.Bamba, V.Wataghin, Nuovo Cim. 10, 174(1953). E.W.Titterton, T.A.Brinkley, Proc. Phys. Soc. 65A, 1052(1952).

No reaction $Li^6(\gamma,d)He^4$ pc
$\sigma$<3.5 x $10^{-3}$ for $E_\gamma$= 2.82 enriched $Li^6$

P.Jensen, K.Gls, Z.Naturf. 8a, 137(1953).

**$Li^7_3$** Level $Li^6(d,p)$ $Be^9(d,\alpha)$ s
0.477

E.R.Collins, C.D.McKenzie, C.A.Ramm, Proc. Roy. Soc. 216A, 242(1953).

Level $Li^6(d,p)$ $E_d$= 1.5
$\gamma$ 0.4774 ± 0.020 sl $pe^-$
Values with Doppler correction

R.G.Thomas, T.Lauritsen, Phys. Rev. 88,969(1952).

Level $Be^9(d,\alpha\gamma)$ $E_d$= 0.40 scin
$\alpha\gamma(\theta)$ (0.478) I = 1/2

R.G.Uebergang, N.W.Tanner, Australian J. Sci. Res. 6A, 53(1953).

**$Li^7_3$** Levels $B^{10}(n,\alpha)$ $E_n$ = th pc
5.8† g.s.
94.2† (0.478)
† Relative cross sections

U.M.Hauser, Z. Naturf. 7a, 781(1952).

Level $Li^6(d,p\gamma)$ $E_d$ = 0.41
$p\gamma(\theta)$ (0.478) I = 1/2

A.J.Salmon, E.K.Inall, Proc. Phys. Soc. 66A, 297(1953).

Levels $Be^9(d,\alpha)$ s

| | $E_d$ = 0.47 | $E_d$ = 1.0 |
|---|---|---|
| g.s. | 100† | 100† |
| (0.478) | 100† | 70† |
| 4.62 | 20† | 100† |

$H^3$ continuum observed from 4.62 level
†Relative yields at 90°

R.W.Gellnas, S.S.Hanna, Phys. Rev. 89, 483(1953).

Level $Li^6(n,t)He^4$ $E_n$ = 0.27 ppl
n,t($\theta$) (7.4) J = 5/2

W.O.Soiano, J.H.Roberts, Phys. Rev. 89, 892A (1953).

Levels $Li^7(\gamma,t)He^4$ $E_\gamma$ = 8.13 ppl
$\gamma,\alpha(\theta)$ suggests 3/2 +, 1/2 − interference
$\sigma$ = 2.7 x $10^{-5}$

M.Nabholz, P.Stoll, M.Wäffler, Helv. Phys. Acta 25, 701(1952).

Resonances $Li^7(\gamma,t)He^4$ $E_\gamma \leq 15$ ppl
~5.25 $\sigma$ =~0.02 mb
7.25 $\sigma$ = 0.13 mb
~9.25 $\sigma$ =~0.02 mb

P.Stoll, M. Wächter, Nuovo Cim. 10,347(1953).

Resonances $Li^7(\gamma,t)He^4$ $E_\gamma \leq 24$ ppl
9.3 21.5 ?
16.7 ? 23.5 ?
No structure resolved for $Li^7(\gamma,p)He^6$

E.W.Titterton, T.A.Brinkley, Proc. Phys. Soc. 66A, 194(1953).

$Li^7(\gamma,n)$ n yield
Yield curve analyzed into straight line segments
Breaks at $E_\gamma$= 9.6, 10.8, 12.4, 14, 17.5

K.Goldemberg, L.Katz, Phys. Rev. 92, 852A(1953).

$Li^6(n,t)He^4$ $E_n$=0.2 to 0.6
n,t($\theta$) shows $l_n$ = 0 and 1 predominant ppl

L.E.Darlington, J.Haugsnes, H.W.Mann, J.H.Roberts, Phys. Rev. 89,892A; 90,1049(1953).

**$Li^8_3$** $\tau$ **0.87$^s$** Li(0.6-Mev d)

P.Bretonneau, Compt. rend. 236, 913(1953).

$\tau$ **0.89$^s$** Li(0.53-Mev d)
(12.5$\beta$)(1.5$\alpha$)($\theta$) not isotropic
No 4.9$\gamma$ (<0.8% of $Li^8$ decays)

D.S.Bunbury, Phys. Rev. 90,1121(1953).

$Li^8_3$ $Li^7(d,p)$ scin $Be^8_4$
$(12.5\beta)(1.5\alpha)(\theta)$ not isotropic

C.M.Class, S.S.Hanna, Phys. Rev. 89,877(1953).

$Li^9_3$ $\beta^-$ and 2 $\alpha$'s found in $\mu$ meson star
$E_\beta \sim 8$, $E_\alpha$(total) = 4.4 indicate decay of $Li^9$ via 6.8 level of $Be^9$

W.F.Fry, Phys. Rev. 89, 325(1953).

$Be^7_4$ $\tau$ (metal) 53.61$^d$ Li(8.5-Mev p)
Counted for 5 months differential ic
$\tau$ dependent on chemical state

J.J.Kraushaar, E.D.Wilson, K.T.Bainbridge, Phys. Rev. 90, 610 (1953).

| Level | $Li^6(d,n)^*$ | $B^{10}(p,\alpha)^{**}$ | sl pe$^-$ |
|---|---|---|---|
| $\gamma$ | 0.4289$^*$ ± 0.0020 | $E_d$ = 1.5 | |
| | 0.4285$^{**}$ ± 0.0018 | $E_p$ = 1.4 | |

Values with Doppler correction

R.G.Thomas, T.Lauritsen, Phys. Rev. 88,969(1952).

Level $B^{10}(p,\alpha)$ $E_p$ = 3.333, 1.460 EA
0.429 ± 0.003

D.S.Craig, D.J.Donahue, K.W.Jones, Phys. Rev. 88, 808(1952).

Level Li(d,n) $E_d$ = 0.93 ppl
1.81?
Can also be interpreted as 13.4 level in $Be^8$

J.Catalá, J.Aguilos, F.Busquet, Anales, real, soc. espan. fis. y quim 49A, 131(1953).

Levels $Li^7(p,n)$ $E_p$ = 18.3 ppl
4.6
7.1

D.M.Thomson, Phys. Rev. 88, 954(1952).

$Li^7(p,n)$ EA
Threshold 1.8816±0.0010
$Li^7(p,n)$thresh/$Mg^{24}(p,p\gamma)$thresh=1.3737±0.0005

K.W.Jones, M.T.McEllistrem, R.A.Douglas, H.T. Richards, Phys. Rev. 91, 482A (1953).

No reaction observed for He($\alpha$,n)
$\sigma < 7 \times 10^{-4}$ for $E_\alpha$ = 39 (threshold = 38)
Consistent with odd parity for g.s.

D.Walker, W.T.Link, W.I.B.Smith, Proc. Phys. Soc. 65A, 961(1952).

$Be^8_4$ $\tau$ $<5\times10^{-14}$s $O^{16}$ ($\lesssim$27-Mev $\gamma$)
From analysis of 38 4$\alpha$-stars

C.H. Millar, A.G.W.Cameron, Can.J.Phys. 31, 723 (1953).

Level $Be^9(d,t)$ ppl
g.s.
d,t($\theta$) for $E_d$ = 0.295, 0.40, 0.45, 0.52, 0.62

D.deJong, P.M.Endt, L.J.G.Simons, Physica 18, 676(1952).

Levels $Be^9(d,t)$ $E_d$ = 1.0 s
3.5$^+$ g.s.
15$^+$ (2.9)
$^+$Relative yields at 90°

R.W.Gellnas, S.S.Hanna, Phys. Rev. 89, 483(1953).

Levels $B^{10}(d,\alpha)$ $E_d$ = 0.59, 0.78, 1.07$^*$
g.s ic
2.9 I = 2$^*$
$^*$From fit of theoretical curve to $\alpha$ energy spectrum
Only two $\alpha$ peaks at $E_\alpha \sim 12, \sim 9$

P.B.Treacy, Phil. Mag. 44, 325(1953).

Levels $Li^6(He^3,p)$ $E_{He^3}$ = 0.72 scin
g.s.
3.2
Only two peaks at $E_p$ = 14.6, 12.0

W.W.Good, W.E.Kunz, C.D.Moak, ORNL-1415(1952).

Level $Li^6(He^3,p)$ $E_{He^3}$ = 0.72
2.9 $\Gamma \sim 1$ scin
No other level observed below 11 Mev

W.E.Kunz, C.D.Moak, W.D.Good, Phys. Rev. 91, 676 (1953).

Levels $Li^7(d,n)$ $E_d$ = 0.68 ppl
2.2 ?$^*$ 4.1
2.9 5.0
$^*$Seen for small angles only
d,n($\theta$) shows both stripping and compound nucleus formation

B.Trumpy, T.Grotdal, A.Graue, Nature 170, 1118 (1952).

Levels $Li^7(d,n)$ $E_d$ = 0.93 ppl

| | | |
|---|---|---|
| 1.52 | 5.0 | 12.3 |
| 2.2 | 7.5 | 12.8 |
| 2.8 | 9.6 | 13.4$^*$ |
| 3.5 | 10.6 | 14.1 |
| 4.0 | 12.1 | |

$^*$Can also be interpreted as 1.61 level in $Be^7$

J.Catalá, J.Aguilor, F.Busquets, Anales real soc. espan. fis. y quim. 49A, 131 (1953).

Levels $B^{11}(\gamma,t)$ $E_\gamma$ = 17.6 ppl
2.9 $\Gamma$ = 1.8
3.4 ± 0.2 $\Gamma$ = 0.8
4.05?

O.Rochat, P.Stoll, Helv. Phys. Acta 25, 451(1952).

| Levels | $B^{10}(\gamma,d)$ | $B^{11}(\gamma,t$ | |
|---|---|---|---|
| | 2.2 | 4.0 | $E_\gamma \lesssim 31$ ppl |
| | 2.9 | 4.9 | |
| | 3.4 | 6.8 | |

All $\alpha$ emitting levels

P.Erdös, P.Scherrer, P. Stoll, Helv. Phys. Acta 26, 207 (1953).

**$Be^8_4$**

Levels $B^{11}(p,\alpha)$ $E_p$ = 0.183

| | | |
|---|---|---|
| 2.2 | 4.0 | ppl, pc |
| 2.9 | 4.9 | |
| 3.4 | | |

H.Güttli, P.Stoll, Helv. Phys. Acta 26, 428 (1953).

Levels $B^{10}(d,\alpha)$ $E_d$ = 1.0 s

2.87 $\Gamma$ = 0.9
4.1?
~5.0
~7.5
9.6?

All $\alpha$ emitting levels $B^{10}(d,3\alpha) < 5\%$

P.Cüer, J.J.Jung, Compt. rend. 236, 2401 (1953).

Levels $C^{12}(\gamma,\alpha)$ $E_\gamma \geq 26$ ppl

$\gamma,\alpha(\theta)$ 2† g.s.
$\alpha\alpha(\theta)$ 10† (3-16)
12† 16.4?
56† 16.8 J=2+ $\Gamma$<0.3 T=1
20† 17.6 J=(2 or 4)+ $\Gamma$<0.3 T=1

$\gamma/\alpha$<0.25 for 16.8 and 17.6 levels
Initial $\alpha$'s from > 25-Mev levels in $C^{12}$

J.J.Wilkins, F.K.Goward, Proc. Phys. Soc. 66A,661 (1953).

Levels

See $C^{12}$, D.L.Livesey, C.L.Smith, Proc. Phys. Soc. 66A, 689 (1953).

$Li^7(p,\gamma)$ EA

Resonance 0.4415 ± 0.0005 $\Gamma$ = 0.0122
Level 17.628

S.E.Hunt, Proc. Phys. Soc. 65A, 982 (1952).

Level $Li^7(p,p)Li^7$ $E_p$= 0.36 to 1.4
$p,p(\theta)$ (17.63) J= 1+

W.D.Warters, W.A.Fowler, C.C.Lauritsen, Phys. Rev. 91, 917 (1953).

Level $Li^7(p,\gamma)$ $E_p$= 1.050
$\gamma$ (18.14) scin

Hard and soft $\gamma$'s resonant at $E_p$= 1.050

A.A.Kraus, Phys. Rev. 92, 1085A (1953).

$p,\alpha(\theta)$ $Li^7(p,\alpha)He^4$ $E_p$ = 0.06 to 0.90
$l_p$ = 1 and 3

F.Hirst, Australian J. Sci. Res. 4A, 284(1951); 5A, 570(1952).

**$Be^9_4$**

Levels Be(p,p') $E_p$ = 31.5 scin

2.5 11.6
6.8

R.Britten, Phys. Rev. 88, 283(1952).

$B^{11}(d,\alpha n)Be^8$ $E_d$= 0.425 scin

n's observed, assigned to 2.4 level of $Be^9$

G.A.Dissanaike, J.O.Newton, Proc. Phys. Soc. 65A, 675(1952).

**$Be^{10}_4$**

Levels $Be^9(d,p)$ $E_d$ = 14.3
$d,p(\theta)$ g.s. $l_n$ = 1
(3.37) $l_n$ = 1

C.F.Black, Phys. Rev. 90, 381A(1953).

Levels $Be^9(d,p)$ $E_d$ = 3.6 lc
$d,p(\theta)$ g.s. $l_n$ = 1
(3.37) $l_n$ = 1

H.W.Fulbright, J.A.Brunner, D.A.Bromley, L.M. Goldman, Phys. Rev. 88, 700(1952).

Level Be(d,p) ppl
g.s.
$d,p(\theta)$ for $E_d$=0.295,0.40,0.45,0.52,0.62

D.deJong, P.M.Endt, L.J.G.Simons, Physica 18,676, (1952);18, 407(1952).

Level Be(d,p) $E_d$ = 1.2
$\gamma$ (3.38) E1 or E2 $e^+$ spectrum

R.G.Thomas, T.Lauritsen, Phys. Rev. 88, 969(1952).

Levels Be(d,p) $E_d$ = 3.49 ppl

No states between g.s. and 3.37 level

F.Ajzenberg, Phys. Rev. 88, 298(1952).

Capture $\gamma$'s $Be^9(n,\gamma)$ pair s

25 † 3.41
75 † 6.81

No 6.3$\gamma$ observed
†Photons per 100 n captures

G.A.Bartholomew, B.B.Kinsey, Can. J. Phys. 31, 49(1953).

**$B^9_5$**

Level $Be^9(p,n)$ $E_p$= 6.59 ppl
2.37

F.Ajzenberg, C.M.Braams, W.W.Buechner, Phys. Rev. 91,674; 91, 463A (1953).

**$B^{10}_5$**

$\mu$ 1.80114* I
1.80082**

*$\nu(B^{10})/\nu(D)$ = 0.700085 ± 0.00007
**$\nu(B^{10})/\nu(Rb^{85})$ = 1.11282 ± 0.00005

$Na_2B_2O_4$, $D_2O$, RbCl

Y.Ting, D.Williams, Phys. Rev. 89, 595(1953).

|q| 0.099 $B(CH_3)_3$ quad res

H.G.Dehmelt, Z.Phys. 134,642(1953);133,528(1952).

No 1.74 level by $B^{10}(d,d')$ $E_d$ = 6.9 s
1.74 level was observed by $B^{10}(p,p')$

C.K.Bockelman, C.P.Browne, A.Sperduto, W.W.Buechner, Phys. Rev. 90,340A(1953).

$\gamma\gamma$ $Be^9(d,n)$ $E_d \leq 1$ scin
(1.02$\gamma$) (0.72$\gamma$) (1.43$\gamma$,2.87$\gamma$) (0.72$\gamma$)

S.W.Shafroth, S.S.Hanna, Phys. Rev. 91,483A(1953).

$B^{10}$ 5 5

| Levels | $Be^9(d,n)$ | | $E_d$=0.60 | ppl |
|---|---|---|---|---|
| 130† | g.s. | 200† | 2.20 | |
| 360† | 0.73 | 60† | 2.85 | |
| 25† | 1.75 | 170† | 3.64 | |

† rel $\sigma$ at 90°

A.J.Dyer, J.R.Bird, Australian J. Phys. 6,45 (1953).

$B^{11}$ 5 6

| Levels | B(d,n) | | $E_d$= 3.39 | ppl |
|---|---|---|---|---|
| d,n($\theta$) | g.s. | $l_p$= 1 | 5.58 | |
| | 0.72 | $l_p$= 1 | 5.93 | |
| | 1.75 | $l_p$= 1 | 6.12 | |
| | 2.15 | $l_p$= 1 | 6.38 | $l_p$= 2 |
| | 3.53 | $l_p$= 1 | 6.58 | |
| | 4.78 | | 6.77 | |
| double | 5.14 | $l_p$= 0 | | |

Possible levels at 5.37,5.72

F.Ajzenberg, Phys. Rev. 88, 298(1953); 87, 205A (1952); 82, 43(1951).

| Level | $B^{10}(p,p')$ | $E_p$ = 2.191 | EA |
|---|---|---|---|
| | 0.719 ±0.0016 | | |

Level value indicates $\tau(0.718\gamma) > 10^{-13}$s

No other levels for $E_p \leq 4.2$

D.S.Craig, D.J.Donahue, K.W.Jones, Phys. Rev. 88, 808(1952).

| Level | B(n,n'$\gamma$) | $E_n$ = 2.5 | |
|---|---|---|---|
| $\gamma$ | 0.717 | | scin |

R.B.Day, Phys. Rev. 89, 908A(1953).

| Levels | $Be^9$(d,n) | $E_d$= 0.86 | ppl |
|---|---|---|---|
| d,n($\theta$) | (3.58) | $l_p$= 1 | |

L.L.Green, J.P.Scanlon, J.C.Willmott, Phil. Mag. 44, 919 (1953).

| Capture $\gamma$'s | $Li^6(\alpha,\gamma)$ | $E_\alpha \leq$ 1.5 | scin |
|---|---|---|---|
| | 4.75 level | I = 1+ | |
| 100† | 4.02 | | |
| | 5.182 level | I = 2+ T = 1? | |
| 70† | 2.99 | | |
| 25† | 4.49 | | |
| 5† | 5.25 | | |

Level at 5.11 not observed; suggest I = 2-

†Transitions relative to sum of all transitions from initial level

D.M.Wilkinson, G.A.Jones, Phys. Rev. 91, 1575 (1953); 90, 722 (1953).

| Capture $\gamma$'s | $Be^9(p,\gamma)$ | | | $E_p$= 1.087 | scin |
|---|---|---|---|---|---|
| | 7.48 level | | $E_p$= 0.998 | | |
| 26† | 0.41 | 26† | 1.4 | | |
| 228† | 0.72 | | 7.5 | | |
| 64† | 1.02 | | | | |
| | 7.56 level | | $E_p$= 1.087 | | |
| 108† | 0.71 | 17† | ~2 | | |
| <5† | 1.4 | 98† | 6.8 | | |

No 0.41$\gamma$ (<0.8†) No 1.02$\gamma$ (<5†) No 7.56$\gamma$

W.F.Hornyak, T.Lauritsen, Phys. Rev. 91,463A (1953); verbal report.

$B^{12}$ 5 7

| | $Be^9(p,\gamma)$ | $E_p$= 2.565 | |
|---|---|---|---|
| $\gamma$ | 8.1 | | s |

(8.1$\gamma$ of $B^{10}$)/(3.57$\gamma$ of $Li^6$) = 0.001

R.J.Mackin, Jr., Phys. Rev. 92, 1084A(1953).

| q | +0.047 | $B(CH_3)_3$ quad res |
|---|---|---|

H.G.Dehmelt, Z.Phys. 134,642(1953); 133,528(1952).

| Levels | $Li^7(\alpha,\gamma)$ | | | |
|---|---|---|---|---|
| | | I* | | I* |
| | 2.14 | 1/2 ± | 8.93 | 3/2 + |
| | 4.46 | 5/2 + | 9.19 | 7/2 + |
| | 5.03 | 1/2 ± | 9.28 | 5/2 − |
| | 6.81 | 3/2 + | | |

*From $\gamma$ intensities, $\alpha,\gamma(\theta)$, and $\gamma\gamma(\theta)$

G.A.Jones, D.M.Wilkinson. Phys. Rev. 88, 423 (1952).

| d,p($\theta$) | B(d,p) | $E_d$ = 0.29 | ppl |
|---|---|---|---|

Graphs for g.s., 2.14, 4.46, and 5.03 levels

P.M.Endt, C.H.Paris, H.M.Jongerius, F.P.G.Valekx, Physica 18, 423(1952).

| Levels | $C^{13}$(d,$\alpha\gamma$) | $E_d$ = 1.8 | |
|---|---|---|---|
| $\gamma$'s | 4.50 | | pair s |
| | 4.96 | | |

R.P.Bent, T.W.Bonner, R.F.Sipple, Phys. Rev. 91, 472A(1953); verbal report.

| Levels | $B^{10}$(d,p) | | $E_d$=4.25 to 8.52 |
|---|---|---|---|
| | 7.99 | 9.19 | sm |
| | 8.57 | 9.28 | |
| | 8.93 | 10.32 double? | |

M.M.Elkind, A.Sperduto, Phys. Rev. 91,463A (1953); verbal report.

| Levels | $Be^9$(d,n)$B^{10}$ | $E_d$ = 0.96 | ppl |
|---|---|---|---|
| d,n($\theta$) | ~16.7 J = $3/2^+$ | | |
| | ~16.7 J = 5/2- | | |

J.S.Pruitt, S.S.Hanna, C.D.Swartz, Phys. Rev. 91 463A (1953).

| | $Be^9$(d,t)$Be^8$ | $E_d$ = 1.3 | ppl |
|---|---|---|---|

d,t($\theta$) shows forward peaking suggesting pick-up

P.Cuer, J.J.Jung, Phys. Rev. 89, 1151(1953).

| | $Be^9$(d,t)$Be^8$ | $Be^9$(d,p)$Be^{10}$ | |
|---|---|---|---|

$\sigma$'s equal for $E_d$ <0.40 ppl

D.deJong, P.M.Endt, L.J.G.Simons, Physica 18, 676(1952).

| $\tau$ | $0.022^s$ | B(0.6-Mev d) |
|---|---|---|

P.Bretonneau, Compt. rend. 236, 913(1953).

| Levels | $B^{11}$(d,p) | | $E_d$=4.25 to 8.52 |
|---|---|---|---|
| | 0.95 | 2.72 | sm |
| | 1.67 | 3.38 | |
| | 2.62 | | |

M.M.Elkind, A. Sperduto, Phys. Rev. 91,463A(1953); verbal report.

$C^{10}_{6\ 4}$

| | | | | |
|---|---|---|---|---|
| $\beta^+$ | | $2.1 \pm 0.1$ | B(18-Mev p) | chem; a |
| $\gamma$ | 100† | 0.72 | $\tau < 2\times10^{-7}$s | $\beta\gamma$ scin |
| | 1.7† | 1.03 | | |

No 1.43$\gamma$ (<0.21†) No 2.15$\gamma$ (<0.024†)
Conclude $\beta^+$ to 1.75 level is 0+→0+
†Photons per disintegration

R.Sherr, J.B.Gerhart, Phys. Rev. 91, 909 (1953).

$C^{11}_{6\ 5}$

| | | | |
|---|---|---|---|
| $\tau$ | $20.25^m$ | $C^{12}$(30-Mev p) | scin |

W.M.Martin, S.W.Breckon, Can. J. Phys. 30, 643 (1952).

| | | | |
|---|---|---|---|
| $\tau$ | $20.74^m$ | C(21-Mev $He^3$) | |

D.N.Kundu, T.W.Donaven, M.L.Pool, J.K.Long, Phys. Rev. 89, 1200(1953); Physica 18, 1304(1952).

$C^{12}_{6\ 6}$

| | | | | |
|---|---|---|---|---|
| Levels | | $B^{11}$(d,n) | $E_d$ = 8.1 | ppl |
| | g.s. | $l_p = 1$ | | |
| | (4.43) | $l_p = 1$ | | |

W.M.Gibson, Phil. Mag. 44, 297(1953).

| | | | |
|---|---|---|---|
| Level | | $C^{12}$(n,n'$\gamma$) | $E_n$ = 5.5 |
| $\gamma$ | 4.45 | | scin |

R.B.Day, Phys. Rev. 89, 908A(1953).

| | | | | |
|---|---|---|---|---|
| Level | | $C^{12}$(p,p'$\gamma$) | $E_p$ = 7.1 | scin |
| p,$\gamma(\theta)$ | (4.43) | I = 2 | | |

H.E.Gove, N.S.Wall, Can J. Phys. 31, 189(1953).

| | | | |
|---|---|---|---|
| Level | | $N^{15}$(p,$\alpha\gamma$) | $E_p$ = 0.429, 0.890, 1.210 s |
| p,$\gamma(\theta)$; p,$\alpha(\theta)$ | (4.43) | I = 2+ | |

A.A.Kraus, Jr., A.P.French, W.A.Fowler, C.C.Lauritsen, Phys. Rev. 89,299(1953).

| | | | |
|---|---|---|---|
| Level | | $N^{15}$(p,$\alpha\gamma$) | $E_p$ = 1.6 |
| | $4.443 \pm 0.020$ | | sl Cpt |

Value with Doppler correction. Use of correction implies $\tau < 3\times10^{-13}$s

R.G.Thomas, T.Lauritsen, Phys. Rev. 88,969(1952).

| | | | |
|---|---|---|---|
| $\gamma$'s | | $Be^9$($\alpha$,n$\gamma$) | |
| 3† | 3.16 | | |
| 100† | (4.43) | | |

No 7.6$\gamma$ (< 0.04†)

L.E.Beghian, H.H.Halban, T.Husain, L.G.Sanders, Phys. Rev. 90,1129(1953).

| | | | | |
|---|---|---|---|---|
| Levels | | $N^{14}$(d,$\alpha$) | $E_d$ = 0.62 | s |
| 100† | (4.43) | | | |
| 6† | $7.68 \pm 0.03$ | | | |

No other level below 9.2 Mev (<1†)

F.Hoyle, D.N.F.Dunbar, W.A.Wenzel, W.Whaling, Phys. Rev. 92, 1095A(1953).

| | | | | |
|---|---|---|---|---|
| Levels | | C(p,p') | $E_p$ = 31.5 | scin |
| | 4.3 | 9.5 | | |
| | 7.5 ? | 11 - 17 unresolved group | | |

R.Britten, Phys. Rev. 88, 283(1952).

$C^{12}_{6\ 6}$

| | | | | |
|---|---|---|---|---|
| Level | | $C^{12}$(n,n$\alpha$)$Be^8$g.s. | $E_n \sim 25$ | cc |
| | 9.7 | $\Gamma$ = 1.6 | | |

J.D.Jackson, D.I.Wanklyn, Phys. Rev. 90,381A(1953).

| | | | |
|---|---|---|---|
| | | $B^{11}$(p,$\gamma$)$C^{12}$ | EA |
| Resonance | $0.1638 \pm 0.0002$ | $\Gamma$ = 0.0073 | |
| Level | 16.099 | absolute measurement | |

S.E.Hunt, W.M.Jones, Phys. Rev. 89,1283(1953).

| | | | | |
|---|---|---|---|---|
| Levels | | $B^{11}$(p,$\alpha$)$Be^8$ | $E_p$ = 0.13 to 0.28 | |
| p,$\alpha(\theta)$ | (16.10) | J = 2+ | | pc |
| | (16.57) | -? | | |

p,$\alpha(\theta, E_p)$ shows interference between 16.10 and higher level

D.W.Thomson, A.V.Cohen, A.P.French, G.W.Hutchinson, Proc. Phys. Soc. 65A, 745(1952).

| | | | |
|---|---|---|---|
| Levels | | $B^{11}$(p,$\gamma$) | $E_p$ = 0.15 to 0.5 |
| | (16.10) | J = 2+ | |
| | (16.57) | -? | |
| | (17.22) | -? | |

p,16$\gamma(\theta, E_p)$ has $\cos^2\theta$ term not f($E_p$)
p,12$\gamma(\theta, E_p)$ has $\cos\theta$ term f($E_p$) showing interference between 16.10 level and higher level a,G-M

H.Glättli, P.Stoll, Helv. Phys. Acta 25, 455(1952).

| | | | |
|---|---|---|---|
| Levels | | $B^{11}$(p,$\gamma$) | $E_p$ = 0.2 to 1.1 |
| | (16.10) | (J = 2+) | |
| | (16.57) | -? | |
| | (17.22) | -? | |

p,12$\gamma(\theta, E_p)$ has $\cos\theta$ term f($E_p$) showing interference between 16.10 level and one or both higher levels scin

G.L.Jenkins, L.W.Cochran, B.D.Kern, T.M.Hahn, Phys. Rev. 91, 915; 91, 210A(1953).

| | | | |
|---|---|---|---|
| Levels | | $B^{11}$(p,$\gamma$) | $E_p$ = 0.6 to 2.8 |
| | (16.57) | J = 2- | |
| | (17.22) | J = (2+) | |
| | 17.8 | | |
| | 18.3 | J = 2+ | |

p,$\gamma(\theta, E_p)$ for 12 and 16 $\gamma$'s

H.E.Gove, E.B.Paul, Phys. Rev. 91, 463A(1953); verbal report.

| | | | | |
|---|---|---|---|---|
| Levels | | $B^{11}$(p,$\gamma$) | | scin |
| ≤6/150† | 16.10 | J = 2+ | ($\Gamma$ = 0.005) | |
| ≤2/48 † | 16.58 | J = 2- | $\Gamma$ = 0.33 | |
| 35/18 † | 17.22 | J = 1- | $\Gamma$ = 1.27 | |

† $\sigma$[(p,$\gamma$)$C^{12}$ g.s.] / $\sigma$[(p,$\gamma$)$C^{12}$ 4.4 level] in $\mu$b

| Level | $\gamma$'s | | |
|---|---|---|---|
| 16.10 | 4.45 | 11.6 (M1) | ~16 (E2) |
| 16.58 | 4.44 | 12.0 (E1) | ~16.4 (M2) |
| 17.22 | 4.45 | 12.7 (E1) | ~16.9 (E1) |

T.Huus, R.B.Day, Phys. Rev. 91,599(1953).

$C^{12}$ 6 6

Levels $B^{11}(p,\alpha)Be^8$ $E_p$= 0.4 to2 s

| | | | |
|---|---|---|---|
| ≤0.2/600† | 16.58 | J = 2- | Γ = 0.3 |
| 6/150† | 17.22 | J = 1- | Γ ~1 |

† $\sigma[(p,\alpha)Be^8$ g.s.$]/\sigma[(p,\alpha)Be^8$~3 level] in mb

O.Beckman, T.Huus, Č.Zupančič, Phys. Rev. 91,606 (1953).

Levels $B^{11}(p,\alpha)Be^8$ $E_p$=0.4 to 2.8 s

| Yield† | Level | J | Γ |
|---|---|---|---|
| 35.4/0.04 | 16.57 | 2- | 0.25 |
| 8.8/1.0 | 17.22 | 2+ | 1.20 |
| 2.3/1.4 | 17.8 | 0+ ? | 0.15 |
| 110.5/2.6 | 18.3 | | 0.30 |

†Relative yield ($Be^8$ 3-Mev level)/($Be^8$ g.s.)α's

E.H.Paul, R.L.Clarke, Phys. Rev. 91,463A (1953).

Level $B^{11}(p,p'\gamma)B^{11}$ $E_p$= 2.5 to 3.0

18.39 → p' + 2.13γ scin

T.Huus, R.B.Day, Phys. Rev. 91,599(1953).

Levels $C^{12}(\gamma,3\alpha)$ $E_\gamma \leq 70$ ppl

18 others ? 310 stars

29

W.K.Dawson, C.B.Bigham, Can. J. Phys. 31, 167 (1953).

Levels $C^{12}(\gamma,3\alpha)$ $E_\alpha \leq 70$ ppl

| | | | |
|---|---|---|---|
| 40† | 12.7 | 110† | 19.5 |
| 35† | 13.8 | 35† | 20.7 |
| 115† | 15.0 | 130† | 21.9 |
| 110† | 15.9 | 30† | 23.2 |
| 125† | 16.8 | 230† | 24.3 |
| 190† | 17.3 | 130† | 25.4 |
| 330† | 18.3 | 270† | 26.5 |
| 130† | 18.9 | st | 29.4 |

F.K.Goward, J.J.Wilkins, Proc. Roy. Soc. 217A (1953); Proc. Phys. Soc. 65A,671(1952).

$O^{16}(\gamma,4\alpha)$ $C^{12}(\gamma,3\alpha)$ $C^{12}(n,n'3\alpha)$

Levels in $O^{16}$,$C^{12}$,$Be^8$ connected by α emission

| $O^{16}$ | $C^{12}$ | $Be^8$ | ppl |
|---|---|---|---|
| 20-24 | 9.6 | g.s. | |
| 20-24 | 11.3 | g.s. | |
| 20-24 | 12 | ~3 | |
| —— | 15-19 | ~3 | |
| —— | >25 | ~17 | |
| 25 | —— | ~4.3 | $O^{16} \rightarrow 2Be^8$ ? |
| 28-30 | 16 | ~3? | |

$E_\gamma \leq$28 to 32

D.L.Livesey, C.L.Smith, Proc. Phys. Soc. 66A,689 (1953).

$C^{12}(\gamma,\alpha)Be^8$ $E_\gamma$ = 17.6 ppl

$\sigma(Be^8$ g.s.$)/\sigma(Be^8$ ~3-Mev level) = 0.025 (cf $O^{16}$)

H.Nabholz, P.Stoll, H.Wäffler, Helv. Phys. Acta 25, 701(1952).

$C^{12}(\gamma,\alpha)Be^8$ $E_\gamma \leq$27 ppl

$\sigma(Be^8$ g.s.$)/\sigma(Be^8$ ~3-Mev level) = ~ 0.09

C.H.Millar, A.G.Cameron, Can. J. Phys. 31,723 (1953).

$C^{12}$ 6 6

$O^{16}(\gamma,4\alpha)$ $E_\gamma \leq$ 48 ppl

Reaction proceeds 90% via 16-Mev $C^{12}$ level for $E_\gamma$> 25

C.A.Hsiao, V.L.Telegdi, Phys. Rev. 90,494;91,473A (1953).

$C^{12}(\gamma,n)$ n yield

Yield curve analyzed into straight line segments

Breaks at $E_\gamma$= 19.3, 19.7, 20.1, 20.5, 20.7, 21.1, 21.6, 22.4, 22.8

L.Katz, J.Goldemberg, Phys. Rev. 92, 852A(1953).

$C^{13}$ 6 7

Levels $C^{12}(d,p)$ $E_d$=7.86 ppl

| | | | |
|---|---|---|---|
| d,p(θ) | g.s. | $l_n$=1 | σ = 0.09 |
| | (3.09) | $l_n$=0 | σ = 0.12 |

J. Catalá, F.Senent, J. Casanova, Anales real soc. espãn. fis. y quim.49A,91(1953).

Level $C(d,p)$ $E_d$= 1.5

γ 3.082 ± 0.007 sl $pe^-$

E1 $e^+$ spectrum

Value with Doppler correction. Use of correction implies $\tau < 3\times10^{-13}$s

R.G.Thomas, T.Lauritsen, Phys. Rev. 88, 969(1953).

d,p(θ) graph $C(d,p)$ $E_d$ = 0.37 ppl

B.Koudijs, P.M.Endt, J.M.van der Hart, P.J.W. Palmer, Physica 18, 415(1952).

Level $C^{13}(p,p')$ $E_p$ = 8 s

3.69

J.C.Arthur, A.J.Allen, R.S.Bender, H.J.Hausman, C.J.McDole, Phys. Rev. 88, 1291(1952).

Capture γ's $C^{12}(n,\gamma)$ pair s

| | |
|---|---|
| 30 † | 3.68 |
| 70 † | 4.95 |

No 3.9γ observed ( < 6 † )

† Photons per 100 n captures

G.A.Bartholomew, B.B.Kinsey, Can. J. Phys. 31, 49(1953).

Capture γ $C^{12}(n,\gamma)$ pair s

4.949 ± 0.006

B.B.Kinsey, G.A.Bartholomew, Can. J. Phys. 31,537 (1953).

$B^{10}(\alpha,p)$ $E_p$ = 1.54

p group to 3.68, 3.89 but not 3.08 level

No 0.7 level (<0.5% of g.s.)

G.Manning, B.Singh, Proc. Phys. Soc. 66A, 842 (1953).

Levels $C^{12}(n,n)C^{12}$ $E_n$ = 2.6 to 4.15

| | | |
|---|---|---|
| n,n(θ) | 7.67 | $d_{3/2}$ |
| | 7.75 | $s_{1/2}$ |

Rise in $\sigma_t$ at $E_n$ = 3.6 not resonance

P.Huber, E.Baldinger, R.Budde, Helv. Phys. Acta 25, 444(1952).

$_{6}C^{13}_{7}$

Level $C^{12}(n,n)C^{12}$ $E_n = 3.62$ scin
n,n($\theta$) (8.20) $d_{3/2}$

A.E.Remund, R.Ricamo, Helv. Phys. Acta 25, 447 (1952).

Levels $Be^{9}(\alpha,n\gamma)C^{12}$ $E_\alpha \leq 3.0$ scin

| $E_o$ |
|---|
| 11.98 1.90 |
| w 12.50 2.65 |

F.L.Talbott, N.P.Heydenburg, Phys. Rev. 90,186 (1953).

$C^{14}_{6\ 8}$

F-K plot linear to 25 kev s

C.S.Wu, A.Schwarzschild, Phys. Rev. 91,483A(1953)

F-K plot concave toward energy axis below 50 kev although $S^{35}$ and $Pm^{147}$ plots linear to 10 kev

J.P.Mize, D.L.Zaffarano, Phys. Rev. 91,210A(1953).

$C^{13}(d,p)$ $E_d = 1.8$ pair s

No 4.1 pair emitting level found

R.D.Bent, T.W.Bonner, R.F.Sipple, Phys. Rev. 91, 472A (1953).

Level $C^{13}(d,p)$ $E_d = 1.4$
$\gamma$ 6.110 ± 0.030 sl Cpt
Value without Doppler correction

R.G.Thomas, T.Lauritsen, Phys. Rev. 88,969(1953).

Level $C^{13}(d,p)$ $E_d = 4.06$ ppl
d,p($\theta$) (8.1) $l_n = 0$

R.E.Benenson, Phys. Rev. 90,420 (1953).

d,p($\theta$) graph $C^{13}(d,p)$ $E_d = 0.37$ ppl

B.Koudijs, P.M.Endt, J.M. van der Hart, P.J.W. Palmer, Physica 18, 415(1952).

$_{7}N^{13}_{6}$

$\tau$ 10.05$^m$ C(0.456-Mev p)

J.L.W.Churchill, W.M.Jones, S.E.Hunt, Nature 172, 460(1953).

$C^{12}(p,\gamma)N^{13}$ EA
Resonance 0.4568 ±0.0005 $\Gamma = 0.040$
Level 2.367 absolute measurement

S.E.Hunt, W.M.Jones, Phys. Rev. 89, 1283 (1953).

$_{7}N^{14}_{7}$

$\mu$ 0.40370 I
$\nu(N^{14})/\nu(Rb^{85}) = 0.74837 \pm 0.00004$
$HNO_3$, RbCl

Y.Ting, D.Williams, Phys. Rev. 89, 595(1953).

Levels $C^{13}(d,n)$ $E_d = 3.89$ ppl
d,n($\theta$)

| $l_R$ |
|---|
| 2.2 1 |
| 3.85 1 |
| 4.80 0 |

$_{7}N^{14}_{7}$

| $l_p$ |
|---|
| 4.97 1? |
| 5.5 0? |
| 5.76 |
| 6.1 |
| 6.23 |
| 6.43 |
| 7.00 1? |
| 7.50 0? |
| 8.08 |

R.E.Benenson, Phys. Rev. 90,420 (1953).

No 2.31 level by N(d,d) $E_d = 6.98$ s$\pi$
2.31 level was observed by N(p,p)

C.K.Bockelmann, C.P.Browne, A.Sperduto, W.W.Buechner, Phys. Rev. 90,340A(1953).

Levels $N^{14}(\alpha,\alpha')$ $E_\alpha = 21.2$ a

| | |
|---|---|
| 4.10 | 7.03 |
| 5.22 | 7.95 |
| 5.72 | 8.64 |
| 6.01 | 9.23 |

2.31 level not observed (isotopic spin forbidden)

B.M.Carmichael, M.B.Sampson, O.E.Johnson, Phys. Rev. 91,473A(1953); verbal report.

Levels $C^{13}(p,p)C^{13}$ $E_p = 0.45$ to 1.60
p,p($\theta$)

| | |
|---|---|
| (8.06) | J = 1- |
| (8.62) | J = 0+ |
| (8.70) | J = 0- |
| 8.90 | J = 2- or 3- |
| 8.98 | J = 1+, 2+, or 3+ |

E.A.Milne, Phys. Rev. 92,1085A(1953).

Levels $C^{13}(p,n)N^{13}$ $E_p$=3.2 to 5.0

| $E_o$ | $\Gamma$ | |
|---|---|---|
| | | pc |
| 11.05 | 3.78 | 0.10 |
| 11.26 | 4.01 | 0.02 |
| 11.35 | 4.10 | 0.15 |
| 11.44 | 4.18 | 0.03 |
| 11.74 | 4.52 | 0.12 |
| 12.0 | 4.8 | 0.10 |

J.K.Bair, J.D.Kington, H.B.Willard, Phys. Rev. 90,575(1953).

Levels $B^{10}(\alpha,p)C^{13}$ $E_p = 0.5$ to 1.5

| |
|---|
| pc |
| 12.29 |
| 12.39 |
| 12.47 |

G.Manning, B.Singh, Proc. Phys. Soc. 66A,842(1953).

Levels $B^{10}(\alpha,p\gamma)C^{13}$ $E_\alpha \leq 3.0$ scin

| $E_o$ |
|---|
| 12.68 1.80 |
| 12.77 1.83 |
| 12.81 1.88 |
| 12.92 1.83 |
| 13.17 2.16 |
| ~13.23 ~2.27 |
| ~13.72 ~2.95 |

F.L.Talbott, N.P.Heydenburg, Phys. Rev. 90,186 (1953).

$N^{14}$ 7 7

Capture $\gamma$'s $C^{13}(p,\gamma)$ $E_p$ = 0.554 scin

| | | | |
|---|---|---|---|
| ~25† | 2.35 | ~18† | 4.45 |
| ~10† | 2.75 | ~ 4† | 5.1 |
| ~15† | 3.05 | 100† | (8.06) |

D.Hicks, T.Husain, L.G.Sanders, L.E.Beghian, Phys. Rev. 90,163(1953).

| | $C^{13}(d,n\gamma)$ | $E_d$ = 1.4, 1.6 |
|---|---|---|
| $\gamma$'s | 0.725* ± 0.004 | 3.381 ± 0.0013 |
| | 1.638 ± 0.008 | 5.052 ± 0.0025 |
| | 2.310 ± 0.012 | 5.690 ± 0.0050 |

Values without Doppler correction sl pe-,Cpt
*Assignment uncertain

R.G.Thomas, T.Lauritsen, Phys. Rev. 88,969(1953).

$\gamma$'s $C^{13}(d,n\gamma)$ $E_d$ = 1.8 pair s

| | |
|---|---|
| 3.36 | 5.72 |
| 5.13 | 6.14? |

R.D.Bent, T.W.Bonner, R.F.Sipple, Phys. Rev. 91, 472A (1953); verbal report.

$N^{15}$ 7 8

Levels $N^{14}(d,p)$ $E_p$ = 5 to 8 s

| | | |
|---|---|---|
| 7.58 | 9.16 | 10.53 |
| 8.31 | 10.06 | 10.69 |
| 8.57 | 10.45 | 10.80 |
| 9.05 | | |

A.Sperduto, W.W.Buechner, M.M.Elkind, W.J.Fader Phys. Rev. 473A (1953); verbal report.

Levels $C^{14}(p,n)$

$p,n(\theta)$

| | |
|---|---|
| (11.294) | J = 1/2(-?) |
| (11.429) | J = 1/2+ |
| (12.096) | J = 5/2- |
| (12.147) | J = 3/2- |
| (12.327) | J = 5/2± |

R.Kay, H.Mark, C.Goodman, Phys. Rev. 91,472A (1953); verbal report.

Levels $N^{14}(n,n)N^{14}$ pc

$n,n(\theta)$

| | |
|---|---|
| (12.327) | $l_n$ = 1 |
| (12.494) | $l_n$ = 2 |

J.L.Fowler, C.H.Johnson, J.R.Risser, Phys. Rev. 91,441A(1943); verbal report.

Level $N^{14}(n,n)N^{14}$ $E_n$ = 1.9 to 3.8

$\sigma_{el}$ 12.93 J = 1/2-

R.Meier, R.Ricamo, P.Scherrer, W.Zünti, Helv. Phys. Acta 26, 451 (1953).

$N^{16}$ 7 9

No 1.0$\gamma$ (<5% of 6.0$\gamma$) O(fast n) scin

F.Boehm, D.C.Peaslee, V.Perez-Mendez, Phys. Rev. 90,1119(1953).

$O^{14}$ 8 6

$\gamma$ 2.30 ± 0.03 scin

$E_\gamma$ agreement with energy of known 2.31 level in $N^{14}$ (I = 0+) shows $O^{14}$ $\beta^+$ transition is 0+ → 0+

W.W.Bell quoted by R.Sherr, J.B.Gerhart, Phys. Rev. 91, 909 (1953).

$O^{15}$ 8 7

Levels $N^{14}(d,n)$ $E_d$ = 7.7 ppl

| | |
|---|---|
| g.s. | $l_p$ = 1 |
| 5.3 | $l_p$ = 2 ? |
| 6.2 | $l_p$ = 1 ? |
| 6.8 | $l_p$ = 0 |
| 7.5 | $l_p$ = 1 ? |
| 8.4 | $l_p$ = 1 ? |
| 9.1 | $l_p$ = 1 ? |

W.M.Evans, T.S.Green, R.Middleton, Proc. Phys. Soc. 66A, 108(1953).

Levels $N^{14}(p,\alpha)20.4^mC^{11}$ $E_p$ = 6.6

| | | |
|---|---|---|
| 11.9 | 12.5 | stacked foils |
| 12.2 | 13.0 | |

J.P.Blaser, F.Marmier, W.Sempert, Helv. Phys. Acta 25, 442(1952).

Capture $\gamma$'s $N^{14}(p,\gamma)$ $E_p$ = 1.06 scin

| | |
|---|---|
| w | 1.46 |
| st | 3.04 |
| st | 5.27 |
| w | 6.82 |
| st | 8.34 |

C.W.Li, Phys. Rev. 92, 1084A(1953).

$O^{16}$ 8 8

Level $O^{16}(p,p')$ $E_p$ = 8 s

| |
|---|
| 6.0 |
| 6.1 |

Doublet separation = 0.087 ± 0.010

J.C.Arthur, A.J.Allen, R.S.Bender, H.J.Hausman, C.J.McDole, Phys. Rev. 88, 1291(1952).

Level $F^{19}(p,\alpha\gamma)$ $E_p$ = 0.34 $\alpha\gamma$

$\gamma$ (6.13) $\tau \lesssim 10^{-9}$s

S. Gorodetzky, R.Armbruster, A.Gallmann, A.Knipper T.Muller, Compt. rend. 237,45(1953).

Levels $F^{19}(p,\alpha\gamma)$ $E_p$ = 0.874, 0.935

$\alpha\gamma(\theta)$

| | | |
|---|---|---|
| (6.91) | I = 2 + | sπ scin |
| (7.12) | I = 1 − | |

J.Seed, A.P.French, Phys. Rev. 88, 1007(1952).

Levels $F^{19}(p,\alpha\gamma)$ D($\gamma$,p) in ppl

$\gamma$ polarization

| | |
|---|---|
| (6.91) | even |
| (7.12) | odd |

L.W.Fagg, S.S.Hanna, Phys. Rev. 88, 1205(1952).

Levels $F^{19}(p,\alpha\gamma)$ $E_p$ = 0.874, 0.935

$p,\alpha(\theta)$

| | |
|---|---|
| (6.91) | I = 2+ |
| (7.12) | I = 1- |

Neither level contains the 2- state predicted from $\alpha$-particle model unless separated by <0.003 from above levels
No level between 7.12 and 7.94; 8.11 and 9.12

R.W.Peterson, W.A.Fowler, C.C.Lauritsen, Phys. Rev. 92, 1085A(1953).

Levels $C^{12}(\alpha,\alpha)C^{12}$ $E_\alpha$=0.5 to 4 pc

$\alpha,\alpha(\theta)$

| | | |
|---|---|---|
| 9.58 | J = 1- | Γ = 0.860 |
| 9.84 | J = 2+ | Γ = 0.001 |

R.W.Hill, Phys. Rev. 90,845(1953).

$O^{16}_{8\ 8}$

Levels $N^{15}(p,\alpha)C^{12}$

$\sigma(E)$ 12.43 J = 1-
13.09 J = 1-

W.A.Fowler, R.G.Thomas, Phys. Rev. 91,473A (1953)

Levels $N^{15}(p,\alpha)C^{12}$ $E_p$ = 0.5 to 1.0 pc

$p,\alpha_o(\theta)$ (12.43) J = 0+
(13.09) J = 1-

G.C.Neilson, D.B.James, C.A.Barnes, Phys. Rev. 92, 1084A (1953).

Levels $N^{15}(p,\alpha\gamma)C^{12}$ scin

$p,\gamma(\theta)$ (12.51) J = 2-
(12.95) J = 2-
(13.24) J = 3- or 4+

4.43$\gamma$ studied for $E_p$ = 0.43,0.90,1.2

C.A.Barnes, D.B.James, G.C.Neilson, Can. J. Phys. 30, 717(1952).

Levels $N^{15}(p,\alpha\gamma)C^{12}$ s

$p,\gamma(\theta)$ (12.51) J = 2 -
$p,\alpha(\theta)$ (12.95) J = 2 -
(13.24) J = 4 +

A.A.Kraus, Jr., A.P.French, W.A.Fowler, C.C.Lauritsen, Phys. Rev. 89, 299(1953).

$O^{16}(\gamma,\alpha)C^{12}$ $E_\gamma$ = 17.6 ppl

$\sigma(C^{12}$ g.s.$)/\sigma(C^{12}$ 4.4-Mev level) >80 (cf $C^{12}$)
$\sigma(C^{12}$ g.s.$) = 2.0 \times 10^{-4}$

H.Nabholz, P.Stoll, H.Wäffler, Helv. Phys. Acta 25, 701(1952).

Levels $O^{16}(n,n')$ $E_n$ = 14.1 cc

(~6 Mev excitation)/(~12 Mev excitation) ~5

J.P.Conner, Phys. Rev. 89, 712(1953).

$\gamma$'s $F^{19}(p,\alpha\gamma)$ $E_p$=0.874, 0.935 scin

(6.91$\gamma$)/(possible 0.78$\gamma$ from 6.91 level) ≥200
(7.12$\gamma$)/(possible 0.98$\gamma$ from 7.12 level) ≥120
(7.12$\gamma$)/(possible 1.06$\gamma$ from 7.12 level) ≥100
Results consistent with small T=1 admixture in levels involved (expected from Coulomb perturbation)

D.H.Wilkinson, G.A.Jones, Phil Mag. 44, 542(1953)

Resonances $O^{16}(\gamma,4\alpha)$ $E_\gamma \leq 20$ to $\leq 70$ ppl
22.6 29.5
25.8

F.K.Goward, J.J.Wilkins, Proc. Phys. Soc. 65A, 671(1952).

Resonances $O^{16}(\gamma,4\alpha)$ $E_\gamma \leq 32$ ppl
22* 29 ?
25

*Alternative modes of disintegration via $Be^8$, $C^{12}$

D.L.Livesey, C.L.Smith, Proc. Phys. Soc. 65A, 758(1952).

Reaction $O^{16}(\gamma,\alpha)C^{12}$ $E_\gamma \leq 27$ pp

$\gamma,\alpha(\theta)$ isotropic; ∴ excited states of $C^{12}$ involved.

C.H.Millar, A.G.W.Cameron, Can. J. Phys. 31, 723 (1953).

$O^{16}_{8\ 8}$

Levels

See $C^{12}$, D.L.Livesey, C.L.Smith, Proc. Phys. Soc. 66A, 689(1953); C.A.Hsiao, V.L.Telegdi, Phys. Rev. 90,494; 91,473A(1953).

$O^{17}_{8\ 9}$

Level $N^{14}(\alpha,p)$ $E_\alpha$ = 4.80 ppl
0.86

E.Hjalmar, H.Slätis, Phys. Rev. 89, 1151(1953).

$\gamma$ 0.8705 ± 0.0020 $\alpha = 7 \times 10^{-6}$
Value without Doppler correction sl pe- ce-

R.G.Thomas, T.Lauritsen, Phys. Rev. 88,969(1953).

Levels $F^{19}(d,\alpha)$ $E_d$ = 1.8,2.0 s

| | | |
|---|---|---|
| 0.883 | 5.229 | 5.95 |
| 3.069 | 5.397 | 6.87 |
| 3.856 | 5.723 | 6.99 ? |
| 4.567 | 5.875 | 7.37 ? |

Relative intensities given

H.A.Watson, W.W.Buechner, Phys. Rev. 88, 1324 (1952).

$O^{16}(n,n)O^{16}$ $E_n$ = 14.1 cc

$n,n(\theta)$ not isotropic for elastic n's
~ isotropic for inelastic

J.P.Conner, Phys. Rev. 89, 712 (1953).

$O^{16}(n,n)$ $E_n$ = 14.1 cc

$n,n(\theta)$ asymmetrical for elastic n's,
~symmetrical for inelastic

J.P.Conner, Phys. Rev. 89, 712(1953).

$F^{17}_{9\ 8}$

Levels $O^{16}(p,p)O^{16}$ $E_p$=0.28 to 4.6

$p,p(\theta)$ (3.11) J = 1/2- pc
(3.88) J = 7/2-?

F.J.Eppling, J.R.Cameron, R.H.Davis, A.S.Divatia A.I.Galonsky, E.Goldberg, R.W.Hill, Phys. Rev.91, 438A(1953).

$F^{18}_{9\ 9}$

Levels $N(\alpha,\alpha)N$ $E_\alpha$= 1.5 to 3.4
6.7
6.8

N. P.Heydenburg, G.M.Temmer, Phys. Rev. 91,439A (1953).

Levels $N(\alpha,p)O^{17}$ $E_\alpha$ = 5.30 cc

| | | |
|---|---|---|
| 5.2 | 6.3 | 7.2 |
| 5.6 | 6.5 | 7.4 |
| 5.9 | 6.8 | 7.6 |

M.C.Kavadiniz, Rev. fac. sci. Univ. Istanbul 17A,1, (1952).

$F^{19}_{9\ 10}$

Levels $Ne^{21}(d,\alpha)$ $E_d$ = 2.129 s
0.113
0.192

C.Milelkowsky, W.Whaling, Phys. Rev. 88, 1254 (1952).

**$F^{19}$** 9 10

Levels $F^{19}(p,p')$ $E_p = 8$ s

| | | |
|---|---|---|
| 1.37 | 3.94 | 4.48 |
| 1.59 | 4.06 | 4.59 |
| 2.82 | 4.41 | 4.76 |

J.C.Arthur, A.J.Allen, R.S.Bender, H.J.Hausman, C.J.McDole, Phys. Rev. 88, 1291(1952).

$\gamma$'s $F^{19}(n,n'\gamma)$ $E_n = 2.5$ scin

0.084
0.114
0.199
1.36

R.B.Day, Phys. Rev. 89, 908A(1953).

Levels $O^{18}(p,\alpha)N^{15}$ pc

$p,\alpha(\theta)$

| Level | $E_o$ | J |
|---|---|---|
| 8.48 | 0.560 | 1/2 ∓ or 3/2 ∓ |
| 8.56 | 0.640 | 3/2 ∓ |
| ~8.6 | ~0.7* | 1/2 ± |
| 8.76 | 0.850 | 1/2 ± |

*Broad background of one or more levels

A.V.Cohen, Phil. Mag. 44, 583(1953).

Levels $O^{18}(p,n)F^{18}$ $E_p$= 2.6 to 3.8

| | | |
|---|---|---|
| 10.472 | 10.958 | 11.265 |
| 10.543 | 11.052 | 11.427 |
| 10.587 | 11.162 | 11.513 |
| 10.844 | | |

H.Mark, C.Goodman, Phys. Rev. 92,1097A(1953).

$F^{19}(\gamma,n)F^{18}$ n yield

Yield curve analyzed into straight line segments

Breaks at $E_\gamma$= 11, 11.5, 11.9, 15.3

J.Goldemberg, L.Katz, Phys. Rev. 92,852A(1953).

**$F^{20}$** 9 11

$\beta^-$ 5.41 F-K plot linear

$\gamma$ 1.631

No $\beta^-$ > 5.4 (< 1%) No $\gamma$ > 1.67 (< 0.25%)

$F^{19}$(1.8-Mev d,p); sl pe-

D.E.Alburger, Phys. Rev. 88, 1257(1952).

Level $F^{19}(d,p)$ $E_d$ = 14.3

d,p($\theta$) g.s. $l_n$ = 2

C.F.Black, Phys. Rev. 90,381A(1953).

Levels $F^{19}(d,p)$ $E_d$ = 3.6 ic

d,p($\theta$) g.s. $l_n$ = 0 and 2

(0.65) $l_n$ = 2

(~2.05) $l_n$ = 2

(~3.49) $l_n$ = 0

D.A.Bromley, J.A.Bruner, H.W.Fulbright, Phys. Rev. 89, 396(1953).

Levels $F^{19}(d,p)$ $E_d$=1.5 to 2.1 s

| | | | | |
|---|---|---|---|---|
| 0.652 | 1.309 | 2.870 | 3.586 | 4.275 |
| 0.828 | 1.970 | 2.966 | 3.681 | 4.310 |
| 0.938 | 2.048 | 3.491 | 3.961 | 5.062? |
| 1.059 | 2.195 | 3.528 | 4.079 | |

Relative intensities given

H.A.Watson, W.W.Buechner, Phys. Rev. 88, 1324 (1952).

**$F^{21}$** 9 12

$\tau$ $5^s$ $F^{19}$(fast t)

E.C.Campbell, J.E.Strain, ORNL-1496 (1952)

**$Ne^{20}$** 10 10

Level $Na^{23}(p,\alpha)$ $E_p$ = 1.46,2.92 EA

1.634

D.J.Donahue, K.W.Jones, M.T.McEllistrem, H.T. Richards, Phys. Rev. 89, 824(1953).

Level $F^{19}(p,\gamma)$ $E_p$ = 0.70 scin

(>7.5$\gamma$) ($\gamma$) 1.66

(~100% of radiative captures go through 1.66 level)

G.A.Jones, D.H.Wilkinson, Proc. Phys. Soc. 65A,1055, (1952).

Level $Na^{23}(p,\alpha\gamma)$ $E_p$ = 1.255

$\alpha\gamma(\theta)$ (1.63) I = 2+ s, scin

J.Seed, Phil. Mag. 44,921 (1953).

Level $Ne^{20}(d,d')$ $E_d$= 7.8 ppl

d,d'($\theta$) 1.66 $l_d$= 1

From theory of Huby and Newns analogous to Butler stripping theory

R.Huby, H.C.Newns, Phil Mag. 42,1442(1951); R.Middleton, C.T.Tai, Proc. Phys. Soc. 64A, 801, (1951).

Levels $O^{16}(\alpha,\alpha)O^{16}$ $E_\alpha$=0.84 to 4.0 pc

$\alpha,\alpha(\theta)$

| | J | $\Gamma$(kev) |
|---|---|---|
| 6.74 | 0+ | 24 |
| 7.18 | 3- | 10 |
| 7.22 | 0+ | 5 |
| 7.45 | 2+ | 10 |
| 7.85 | 2+ | 3 |

J.R.Cameron, Phys. Rev. 90, 839; 89,909A(1953).

$F^{19}(p,\gamma)Ne^{20}$ EA

Resonance 0.2244±0.0004 $\Gamma$ = 1 kev

Level 13.083 absolute measurement

S.E.Hunt, W.M.Jones, Phys. Rev. 89, 1283 (1953).

Resonances $F^{19}(p,\alpha\gamma)O^{16}$

0.3404 ± 0.0004 $\Gamma$ = 2.9 kev

0.4831 ± 0.0005 $\Gamma$ = 2.2 kev

S.E.Hunt, Proc. Phys. Soc. 65A, 982(1952).

$F^{19}(p,\alpha\gamma)O^{16}$ s

Resonance 0.8725 ± 0.0018

Level 13.699 absolute measurement

K.F.Famularo, G.C.Phillips, Phys. Rev. 91,1195(1953).

Resonances $F^{19}(p,\alpha\gamma)O^{16}$ s $\pi$ scin

| | | J |
|---|---|---|
| $\alpha\gamma(\theta)$ | 0.669 | 1 + |
| $\alpha\gamma(\theta)$; $p,\gamma(\theta)$ | 0.874 | 2 − |
| $\alpha\gamma(\theta)$ | 0.935 | 1 + |

J.Seed, A.P.French, Phys. Rev. 88, 1007(1952).

**$Ne^{20}$** (10 10)

Resonances $F^{19}(p,\alpha)O^{16}$ g.s. pc
$p,\alpha(\theta)$

| | J | Rel. Yield | $\Gamma$ |
|---|---|---|---|
| 1.09 | | 0.13 | 0.03 |
| 1.23 | | 0.26 | 0.08 |
| 1.38 | 2 + | 1.0 | 0.10 |
| 1.73 | 0 + | 3.0 | 0.10 |
| 1.91 | 1 − | 6.0 | 0.20 |

E.B.Paul, R.L.Clarke, W.T.Sharp, Phys. Rev. 90,381A(1953); verbal report.

**$Ne^{21}$** (10 11)

Levels $Ne^{20}(d,p)$ $E_d$ = 7.8 ppl
$d,p(\theta)$

| | I | $l_n$ |
|---|---|---|
| g.s. | $d_{3/2}$ * | 2 |
| (0.33) | $d_{5/2}$ * | 2 |
| (1.68) | | 0 or 1 |
| (2.79) | | 0 |

For levels at 3.73, 4.71, 5.44, 5.74, 7.30, $l_n$ = 1 or 2
*From relative cross-sections

R.Middleton, C.T.Tai, Proc. Phys. Soc. 65A, 752 (1952).

**$Ne^{22}$** (10 12)

Levels $F^{19}(\alpha,p)$ $E_\alpha$ = 5.30 ppl
0.57
1.34
2.84

E.Hjalmar, H.Slätis, Arkiv Fysik 4, 323(1952).

**Na**

Neutron resonance (ev) $E_n$ = 1 ev to 10 kev
~3500 $\sigma_o\Gamma^2 = 58 \times 10^6$

E.R.Hodgson, J.F.Gallagher, E.W.Bowey, Proc. Phys. Soc. 65A, 992(1953).

**$Na^{21}$** (11 10)

$\tau$ $27^s$ Na(≤70-Mev$\gamma$)
$\beta^+$ 2.5 scin

F.J.Boley, Iowa State Coll. J. Sci. 27, 129(1953)

Levels Ne(p,p') Ne $E_p$=0.2 to 4.4 pc

| | | |
|---|---|---|
| 4.20 | 5.04 | 5.58 |
| 4.31 | 5.50 | 6.48 |
| 4.48 | 5.83 | |

W.Haeberli, A.Galonsky, E.Goldberg, R.Douglas, Phys. Rev. 91, 438A; 91, 439A (1953).

**$Na^{22}$** (11 11)

$\beta^+$ 100† 0.540 s
0.08† 1.83 $D_2$ fits spectral shape

B.T.Wright, Phys. Rev. 90,159;89,902A(1953).

$\epsilon_k/\beta^+$ = 0.08 $\beta^+\gamma$ scin pc

R.H.Miller, R.Sherr, Phys. Rev. 92, 848A (1953).

$\gamma$ (1.28) $\alpha = 7 \times 10^{-6}$ s ce$^-$

G.Hinman, D.Brower, R.Leamer, Phys. Rev. 90,370A(1953).

**$Na^{23}$** (11 12)

Level $Na^{23}(p,p')$ $E_p$ = 1.46 EA
0.439

D.J.Donahue, K.W.Jones, M.T.McEllistrem, H.T. Richards, Phys. Rev. 89, 824(1953).

**$Na^{23}$** (11 12)

Levels Ne(p,p) Ne $E_p$=2.4 to 3.8 pc

| | |
|---|---|
| 11.14 | 11.56 |
| 11.36 | 11.87 |
| 11.53 | |

W.Haeberli, A.Galonsky, E.Goldberg, R.Douglas, Phys. Rev. 91, 438A; 91, 439A (1953).

**$Na^{24}$** (11 13)

I 4 M
$\mu$ +1.690
$\Delta F = \pm 1$, $\Delta m = \pm 1$ transitions studied
$\Delta\nu(Na^{24}) / \Delta\nu(Na^{23})$ = 1139.35/1771.61

E.H.Bellamy, K.F.Smith, Phil. Mag. 44, 33(1953).

$\tau$ $14.97^h \pm 0.02$ Na(pile n)
Counted for 5 half-lives with $\beta$ electroscope

E.E.Lockett, R.H.Thomas, Nucleonics 11, No.3, 14(1953).

Level $Na^{23}(d,p)$ $E_d$= 1.15 ppl
$d,p(\theta)$ g.s. $l_n$= 2

S.Takemoto, T.Dazai, R.Chiba, Phys. Rev. 91,1024 (1953).

$\gamma$ (1.38) $\tau \leq 2 \times 10^{-9}$ s $\beta\gamma$

T.C.Engelder, Phys. Rev. 90, 259 (1953).

$\gamma$ 1.3679 ± 0.0010 s $m/2$ pe$^-$
2.7535 ± 0.0010

A.Hedgran, D.Lind, Arkiv Fysik 5, 177(1952).

$\gamma$ 2.753 ± 0.005 pair s

B.B.Kinsey, G.A.Bartholomew, Can. J. Phys. 31,537 (1953).

$\gamma$ (1.38) $\alpha_{pair} = 0.6 \times 10^{-4}$ E2 sl
(2.76) $\alpha_{pair} = 7.1 \times 10^{-4}$ E2

S.D.Bloom, Phys. Rev. 88, 312(1952); 87, 236A(1952); 87, 181(1952).

$\gamma$ (1.38) $\alpha_{pair} = 3 \times 10^{-5}$ E2 sl
(2.76) $\alpha_{pair} = 8 \times 10^{-4}$ E2

H.Slätis, K.Siegbahn, Arkiv Fysik 4, 485(1952).

Levels $Na^{23}(d,p)$ ppl

| | | |
|---|---|---|
| 0.472 | 3.409 | 3.899 |
| 0.564 | 3.582 | 3.929 |
| 1.341 | 3.623 | 4.184 |
| 1.844 | 3.648 | 4.202 |
| 1.884 | 3.738 | 4.219 |
| 2.464 | 3.850 | 4.558 |
| 2.561 | | |

A.Sperduto, W.W.Buechner, Phys. Rev. 88, 574 (1952).

Capture $\gamma$'s $Na^{23}(n,\gamma)$ 2 crystal scin s

| | | | |
|---|---|---|---|
| 50† | 0.48 | 5† | 1.66 |
| 18† | 0.86 | 11† | 2.0 |
| 10† | 1.34 | 24† | 2.53 |

†Photons per 100 n captures

J.T.Braid, Phys. Rev. 90,355A(1953); verbal report.

**$Na^{24}$** 11 13

| Capture γ's | $Na^{23}(n,\gamma)$ | | sl $pe^-$, Cpt |
|---|---|---|---|
| 60† | 0.475 | 20† | 2.07 |
| 50† | 0.877 | 30† | 2.52 |
| 20† | 1.75 | | |

†Photons per 100 n captures

M.T.Motz, Phys. Rev. 90,355A(1953); verbal report.

Neutron resonances $E_n$ = 0.12 to 1
12 resonances, Γ's, J's

P.H.Stelson, W.M.Preston, Phys. Rev. 88, 1354 (1952).

**Mg**

| Capture γ's | Mg(n,γ) | 2 cryst | scin |
|---|---|---|---|
| | 1.07? | | |
| | 1.9 | | |
| | 2.8 | | |

T.H.Braid, Phys. Rev. 91, 442A(1953); verbal report.

| Levels | Mg(p,p') | $E_p$ = 8 | s |
|---|---|---|---|
| | 3.54 | | |
| | 4.71 | | |
| | 5.03 | | |

M.J.Hausman, A.J.Allen, J.S.Arthur, R.S.Bender, C.J.McDole, Phys. Rev. 88, 1296(1952).

**$Mg^{24}$** 12 12

| Resonance | $Na^{23}(p,\alpha\gamma)Ne^{20}$ | | |
|---|---|---|---|
| (α)(1.63γ)(θ) | 1.255 | J = 1+ | s scin |

No g.s. α's observed

J.Seed, Phil. Mag. 44, 921 (1953).

| Level | Mg(n,n'γ) | $E_n$ = 2.5 | |
|---|---|---|---|
| γ | 1.365 | | scin |

R.B.Day, Phys. Rev. 89, 908A(1953).

| Level | Mg(p,p') | $E_p$ = 2.41 | EA |
|---|---|---|---|
| | 1.371 ± 0.002 | | |

D.J.Donahue, K.W.Jones, W.T.McEllistrem, H.T. Richards, Phys. Rev. 89, 824(1953).

| Level | $Mg^{24}(d,d')$ |
|---|---|
| d,d'(θ) | (1.38) $l_n$ = 2 |

From theory of Huby and Newns analogous to Butler stripping theory

R.Huby, H.C.Newns, Phil. Mag. 42, 1442(1951); J.R.Holt, C.T.Young, Nature 164,1000(1949).

| Levels | Mg(p,p') Al(p,α) | $E_p$ = 8 | s |
|---|---|---|---|
| | 1.38 | | |
| | 4.13 | | |
| | 4.24 | | |

g.s. α group not observed

H.J.Hausman, A.J.Allen, J.S.Arthur, R.S.Bender, C.J.McDole, Phys. Rev. 88, 1296(1952).

| Level | Mg(n,n'γ) | $E_n$ = 14 | scin |
|---|---|---|---|
| γ | 1.44 | | n'γ |

R.E.Garrett, F.L.Hereford, B.W.Sloope, Phys. Rev. 91, 441A (1953); verbal report.

**$Mg^{24}$** 12 12

| Capture γ's | $Na^{23}(p,\gamma)$ | | $E_p$ = 0.305 scin |
|---|---|---|---|
| 28† | 1.38 | ≤5† | 5.8 |
| ≤4† | 2.41 ? | ≤2† | 6.2 |
| 24† | 2.88 ? | 20† | 6.8 |
| | ~3.6 | | 7.5 |
| | 4.2 | 11† | 10.3 |

H.Casson, Phys. Rev. 87, 215A(1952); 89, 809 (1953).

**$Mg^{25}$** 12 13

| Levels | $Mg^{24}(d,p)$ | $E_d$ = 8 | pc |
|---|---|---|---|
| d,p(θ)15.4† | g.s. | $l_n$ = 2 | |
| 6.2† | (0.58) | $l_n$ = 0 | |
| 6.2† | (0.98) | $l_n$ = 0 | |
| | (1.61) | isotropic | |
| 5.5† | (1.96) | $l_n$ = 2 | |
| | (~2.7) | $l_n$ = 0 | |
| 8.7† | (3.40) | $l_n$ = 1 | |
| | 4.62 | | |
| | 5.05 | | |
| | 5.49 | | |
| | 6.40 | | |

J.R.Holt, T.N.Marsham, Proc. Phys. Soc. 66A, 258 (1953).

| Levels | Mg(p,p') | $E_p$ = 8 | s |
|---|---|---|---|
| | 0.61 2.76 | complex ? | |
| | 1.62 3.41 | | |
| | 1.98 3.91 | | |
| | 2.56 | | |

H.J.Hausman, A.J.Allen, J.S.Arthur, R.S.Bender, C.J.McDole, Phys. Rev. 88, 1296(1952).

| Capture γ's | Mg(n,γ) | pair s |
|---|---|---|
| | 3.918 | |
| 3.6† | 6.358 | |

Assignment by agreement with d,p results
† Photons per 100 n captures in Mg
Other lines not remeasured

B.B.Kinsey, G.A.Bartholomew, Can. J. Phys. 31, 901 (1953).

**$Mg^{26}$** 12 14

| Levels | $Mg^{25}(d,p)$ | $E_d$ = 8 | pc |
|---|---|---|---|
| d,p(θ) ~2† | g.s. | | |
| 13† | (1.83) | $l_n$ = 0(60%), 2(40%) | |
| 5.7† | (2.97) | $l_n$ = 0 | |
| 6.1† | (3.97) | $l_n$ = 0 | |
| 5.6† | (4.35) | $l_n$ = 0 | |
| 3.3† | (6.15) | $l_n$ = 0 | |
| | 7.29 | | |
| | 8.28 | | |

J.R.Holt, T.N.Marsham, Proc. Phys. Soc. 66A, 258 (1953).

| Levels | $Na^{23}(\alpha,p)$ | $E_\alpha$ = 5.30 | ppl |
|---|---|---|---|
| | 0.40 | | |
| | 1.72 | | |
| | 2.72 | | |

E.Hjalmar, H.Slätis, Arkiv Fysik 4, 323(1952).

| Levels | $Mg^{26}(p,p)$ | s |
|---|---|---|
| | 1.83 | |
| | 2.96 | |

H.J.Hausman, A.J.Allen, J.S.Arthur, R.S.Bender, C.J.McDole, Phys. Rev. 88, 1296(1952).

**$Mg^{26}$** 12 14

Levels — $Na^{23}(\alpha,p\gamma)$ — $p\gamma$ scin

| Levels | $\gamma$'s | | |
|---|---|---|---|
| 1.83 | 1.83 | | |
| 2.97 | 1.14(6†) | (2.97)(1†) | 1.83(6†) |
| 3.97 | 2.14 | (3.97)(vw) | 1.83 |
| 4.35 | 1.38 | 1.14 | 1.83 |

Presence of 0.44 level in doubt

J.E.May, B.P.Foster, Phys. Rev. 90,243; 90,370A (1953).

**$Mg^{27}$** 12 15

$\tau$ 9.39$^m$ ±0.03 Mg(pile n)
Counted with $\beta$ electroscope

K.J.Bobin, E.E.Lockett, quoted by E.E.Lockett, R.M.Thomas, Nucleonics 11, No. 3, 14(1953).

$\tau$ 9.45$^m$ ±0.03 Mg(pile n)
Counted with $\beta$ electroscope

B.W.Sargent, L.Yaffe, A.P.Gray, Can. J. Phys. 31, 235(1953).

$\tau$ 9.51$^m$ ± 0.03
$\beta^-$ 41.4% 1.59 s
58.2% 1.75
0.4% 2.6
$\gamma$ 0.84 ´ s $pe^-$ scin
1.02
(1.59$\beta$)(1.02$\gamma$) (1.75$\beta$)(0.84$\gamma$) scin
No $\gamma\gamma$ (< 0.5%)

H.Daniel, L.Koester, Th. Mayer-Kuckuk, Z.Naturf. 8A, 447 (1953).

Levels — $Mg^{26}(d,p)$ — $E_d$ = 8 — pc

| Levels | | $l_n$ |
|---|---|---|
| d,p($\theta$)2.8 † | g.s. | $l_n$ = 0 |
| 4.6 † | (0.99) | $l_n$ = 2 |
| | 3.50 | $l_n$ = 0 |

J.R.Holt, T.N.Marsham, Proc. Phys. Soc. 66A, 258(1953).

Capture $\gamma$ — $Mg(n,\gamma)$ — pair s

| | |
|---|---|
| 13† | 6.440 |

Assignment by agreement with d,p results
†Photons per 100 n captures in $Mg^{26}$
Other lines not remeasured

B.B.Kinsey, G.A.Bartholomew, Can. J. Phys. 31, 901 (1953).

**$Mg^{28}$** 12 16

$\tau$ 20.8$^h$ Si,K(420-Mev p)
$\beta^-$ 0.42 F-K plot linear chem; sl
No other $\beta$(≤10%)

L.Marquez, Phys. Rev. 90, 330 (1953).

$\tau$ 22.1$^h$ Si(350-Mev p)
p 2.3$^m$Al chem
$\beta^-$ 0.3 a
Several $\gamma$'s up to 2.6 scin

J.W.Jones, T.P.Kohman, Phys. Rev. 90, 495(1953).

**$Mg^{28}$** 12 16

$\tau$ 21.4$^h$ Mg(56-Mev $\alpha$)
$\beta^-$ 0.39 a
$\gamma$ 70† 0.032 $\alpha$<1 scin
†Photons per 100 $Mg^{28}$ decays

A.H.Wapstra, A.L.Veenendaal, Phys. Rev. 91, 426 (1953).

$\tau$ 21.3$^h$ p 2.3$^m$Al Mg(39-Mev $\alpha$)
Si(≤100-Mev $\gamma$) chem

R.K.Sheline, N.R.Johnson, Phys. Rev. 89, 520(1953).

$\tau$ 21.2$^h$ p 2.3$^m$Al chem
$\beta^-$ ~0.4 Cl(340-Mev p) chem
$\gamma$ 0.027 pc
Other $\gamma$'s in agreement with Sheline, Johnson

M.Lindner, Phys. Rev. 91, 642; 89, 1150 (1953).

$\tau$ 21.8$^h$ p 2.3$^m$Al Mg(t,p) chem
$\gamma$ 0.391 scin
~1
~1.3

E.Iwersen, W.S.Koski, F.Rasetti, Phys. Rev. 91, 1229 (1953).

$\beta^-$ 0.40 Mg(39-Mev$\alpha$) a
$\gamma$ ~0.03 chem scin
30† 0.40
28† 0.95
71† 1.35

R.K.Sheline, N.R.Johnson, Phys. Rev. 90, 325, (1953).

**$Al^{24}$** 13 11

$\tau$ 2.10$^s$ Mg(20-Mev p)
$\gamma$ 2.9 scin
4.3
5.3
7.1

N.W.Glass, L.K.Jensen, J.R.Richardson, Phys. Rev. 90, 320 (1953).

**$Al^{25}$** 13 12

$\tau$ 7.6$^s$ $Mg^{24}$(0.418-Mev p)

J.L.W.Churchill, W.M.Jones, S.E.Hunt, Nature 172, 460 (1953).

Levels — $Mg^{24}(d,n)$ — $E_d$ = 3.97 — ppl

| Levels | | $l_p$ |
|---|---|---|
| d,n($\theta$) | g.s. | $l_p$ = 2 |
| | 0.45 | $l_p$ = 0 |
| | 0.95 | $l_p$ = 1 or 2 |
| | 1.81 | |
| | 1.94 ? | |
| | 2.51 | |
| | 2.70 | |
| | 2.92 ? | |
| | 3.09 | |

E.Goldberg, Phys. Rev. 88, 159A(1952); 89, 760 (1953).

**$Al^{25}$** (13 12)

Capture $\gamma$'s — $Mg(p,\gamma)$ — $E_p = 0.27$ scin

| | |
|---|---|
| ~6† | 0.48 |
| 6† | 1.95 |
| 2† | 2.35 |

No higher energy $\gamma$'s observed

H.Casson, Phys. Rev. 87, 215A(1952); 89, 809 (1953).

Resonance — $Mg^{24}(p,\gamma)Al^{25}$ — EA

0.4180±0.0005 $\Gamma$ = 0.0040
absolute measurement

S.E.Hunt, W.M.Jones, Phys. Rev. 89,1283(1953).

**$Al^{26}$** (13 13)

$\tau$ — $6.7^{S}$ — $Mg^{25}$(0.392-Mev p)

J.L.W.Churchill, W.M.Jones, S.E.Hunt, Nature 172, 460 (1953).

**$Al^{27}$** (13 14)

q — +0.149 — I

H.Lew, G.Wessel, Phys. Rev. 90, 1 (1953).

Levels — Al(n,n′) — $E_n = 2.4$ scin

0.35 ?
~0.9

W.J.Poole, Phil. Mag. 43, 1060(1952).

Level — Al(p,p′) — $E_p = 2.31$ EA

0.843

D.J.Donahue, K.W.Jones, M.T.McEllistrem, H.T. Richards, Phys. Rev. 89, 824(1953).

Levels — Al(n,n′$\gamma$) — $E_n = 2.5$ scin

$\gamma$: 0.843, 1.018, 2.20

R.B.Day, Phys. Rev. 89, 908A(1953).

Levels — Al(n,n′$\gamma$) — $E_n = 14$ scin

$\gamma$: 0.81?, 1.03, 2.34 — n′$\gamma$

R.E.Garrett, F.L.Hereford, S.W.Sloope, Phys. Rev. 91,441A (1953); verbal report.

Resonances — $Mg^{26}(p,\gamma)Al^{27}$* — EA

| | $\Gamma$ |
|---|---|
| 0.3148±0.0005 | 0.004 |
| 0.3385±0.0005 | 0.002 |
| 0.3894±0.0005 | 0.004 |
| 0.4365±0.0004 | 0.004 |
| 0.4542±0.0003 | <0.001 |
| ($Al^{27}$?) 0.484 ±0.0010 | 0.010 |

absolute measurement

*Assignment from Tangen who found no $\beta^+$

S.E.Hunt, W.M.Jones, Phys. Rev. 89,1283(1953).

Capture $\gamma$'s — $Mg(p,\gamma)$ — $E_p$= 0.338 scin

| | |
|---|---|
| 35† | 2.8 |
| 45† | 5.8 |

H.Casson, Phys. Rev. 87, 215A(1952); 89, 809(1953).

**$Al^{28}$** (13 15)

$\tau$ — $2.27^{m}$ ± 0.02 — Al(pile n)

Counted 5 samples each for 5 half-lives

R.M.Bartholomew, F.Brown, W.D.Howell, W.R.J. Shorey, L.Yaffe, Can. J. Phys. 31,714(1953).

$\beta^-$ — 2.85 — d $21^{h}$ Mg — chem; sl F-K plot linear

L.Marquez, Phys. Rev. 90,330 (1953).

$\gamma$ — 1.78 — d $21^{h}$ Mg — scin

R.K.Sheline, N.R.Johnson, Phys. Rev. 90,325(1953)

Levels — $Al^{27}(d,p)$ — $E_d$ ~8 pc

d,p($\theta$) — $\downarrow_0$

g.s. doublet (1.0) — 0 — 0 (10%), 2 (90%)

J.R.Holt, T.N.Marsham, Proc. Phys. Soc. 65A, 763 (1952).

Levels — Al(d,p) — $E_d$ = 2.1 s ppl

| | | | | |
|---|---|---|---|---|
| 0.031 | 2.652 | 3.873 | 4.734 | 5.372 |
| 0.974 | 2.980 | 3.900 | 4.759 | 5.435 |
| 1.015 | 3.006 | 3.932 | 4.837 | 5.735 |
| 1.367 | 3.291 | 4.031 | 4.898 | 5.755 |
| 1.625 | 3.342 | 4.115 | 4.988 | 5.792 |
| 2.137 | 3.458 | 4.238 | 5.007 | 5.855 |
| 2.198 | 3.532 | 4.307 | 5.128 | 6.011 |
| 2.268 | 3.587 | 4.457 | 5.156 | 6.190 |
| 2.484 | 3.665 | 4.512 | 5.169 | 6.307 |
| 2.578 | 3.695 | 4.686 | 5.182 | |

Relative intensities given

H.A.Enge, W.W.Buechner, A.Sperduto, Phys. Rev. 88, 963(1952).

**$Al^{29}$** (13 16)

$\gamma$ — 85† 1.28 — 15† 2.43 — scin

No 2.04$\gamma$ (<4%)

H.Roderick, O.Lönsjö, W.E.Meyerhof, Phys. Rev. 90, 371A(1953).

**Si** — Relative abundances — $SiF_4$; ms

| A | 28 | 29 | 30 |
|---|---|---|---|
| % | 92.18 | 4.71 | 3.12 |

J.H.Reynolds, Phys. Rev. 90,1047 (1953).

**$Si^{27}$** (14 13)

$\tau$ — $4.45^{S}$ — Si(≤25-Mev $\gamma$)

R.G.Summers-Gill, R.N.Haslam, L.Katz, Can. J.Phys. 31,70 (1953).

**$Si^{28}$** (14 14)

Resonances — $Al^{27}(p,\alpha)Mg^{24}$ — $Al^{27}(p,\gamma)Si^{28}$

| $E_o$ | $\alpha_o/\gamma$† | |
|---|---|---|
| 0.503 | 1.3 | s |
| 0.630 | 1.1 | $E_p$= 0.40 to 0.75 |
| 0.652 | <0.1 | |
| 0.677 | <0.3 | |
| 0.728 | 4.2 | |
| 0.733 | <0.3 | |

†(yield $\alpha$'s to $Mg^{24}$ g.s.)/(yield ~12.1 $E_\gamma$ to $Si^{28}$ g.s.)

J.G.Rutherglen, R.D.Smith, Proc. Phys. Soc. 66A, 800(1953).

**$Si^{28}$** (14 14)

Capture $\gamma$'s $Al^{27}(p,\gamma)$ $E_p$ = 0.325, 0.404

| | | | | |
|---|---|---|---|---|
| 12 † | 1.81 | ~14 † | 7.1 | scin |
| 12 † | 2.82 | | 7.5 | |
| 5 † | 4.65 | | | |
| | 5.0 | | | |

M.Casson, Phys. Rev. 87, 215A(1952); 89, 809 (1953).

Resonances $Al^{27}(p,\gamma)Si^{28}$ EA

| | $\Gamma$ |
|---|---|
| 0.226±0.0015 | ~0.001 |
| 0.2941±0.0005 | <0.001 |
| 0.3256±0.0004 | <0.001 |
| 0.4047±0.0004 | 0.0007 |
| 0.4385±0.0005 | <0.001 |
| 0.5040±0.0006 | 0.0007 |

absolute measurements

S.E.Hunt, W.M.Jones, Phys. Rev. 89,1283(1953).

Resonances $Mg^{24}(\alpha,p)Al^{27}$ $Al^{27}(p,\alpha)Mg^{24}$
Same $Si^{28}$ levels observed in both reactions
Resonances $Mg^{24}(\alpha,\alpha)$ $E_\alpha$ = 2.7 to 3.4

S.G.Kaufmann, G.Goldberg, L.J.Koester, F.P.Mooring, Phys. Rev. 88, 673(1952).

**$Si^{29}$** (14 15)

Levels Si(d,p) $E_d$ = 14.3
d,p($\theta$) g.s. $l_n$ = 0
(1.29) $l_n$ = 2

C.F.Black, Phys. Rev. 90,381A(1953).

Levels $^{*}$Si(d,p) $E_d$ = 8.21 a pc
d,p($\theta$)

| | $l_n$ | d$\sigma$/d$\Omega$† |
|---|---|---|
| g.s | 0 | 82 |
| (1.278) | 2 | 6.2 |
| (2.027) | 2 | 2.4 |
| (2.428) | * | 0.7 |
| (3.070) | 2 | 1.2 |
| (3.823) | 3 | 4.0 |
| (4.934) | 1 | 55 |
| (6.380) | 1 | 32 |

†mb/sterad at maximum of angular distribution
*angular distribution isotropic

J.R.Holt, T.N.Marsham, Proc. Phys. Soc. 66A,467 (1953); Phys. Rev. 89,665(1953).

**$Si^{29}$?** (14 15)

Capture $\gamma$'s Si(n,$\gamma$) 2 cryst scin
1.26
2.13

T.H.Braid, Phys. Rev. 91, 442A(1953); verbal report.

Resonances Mg($\alpha$,n)Si $E_\alpha$ = 5.3 a
4.6
4.8

Excitation function given

J.Nagy, Acta Physica Acad. Sci. Hung. 3,15(1953).

**$Si^{30}$** (14 16)

Levels Si(d,p) $E_d$ = 8.21 a pc
d,p($\theta$) (5.07) $l_n$=0
(5.50) $l_n$=0 or 2

J.R.Holt, T.N.Marsham, Proc, Phys. Soc. 66A,467 (1953).

**$Si^{31}$** (14 17)

$\tau$ 2.62$^h$
$\beta^-$ 1.48 a

A.Wennerblom, K.E.Zimen, E.Ehn, Svensk Kem. Tid. 63, 207(1951).

$\tau$ 2.62$^h$ P(d,2p) chem; ic

L.J.de Vries, F.T.H.Veringa, J.Clay, Koninkl. Ned. Akad. Wetenschap., Proc. 55B, 303(1952).

**$Si^{31}$?** (14 17)

Levels Si(d,p) $E_d$= 8.21 a pc
d,p($\theta$) (0.757) $l_n$=0
(1.699) $l_n$=0 or 2

J.R.Holt, T.N.Marsham, Proc. Phys. Soc. 66A,467 (1953).

**$Si^{32}$** (14 18)

Abundance <$4\times10^{-6}$% of natural silicon
No $P^{33}$ $\beta$'s observed, $Si^{32}(n,\gamma)$ $Si^{33}\rightarrow P^{33}$
Assumed $\sigma(n,\gamma)$ = 0.05

A.Turkevich, A.Tompkins, Phys. Rev. 90,247(1953).

$\tau$ ~700$^{y*}$ Cl(340-Mev p) chem
$\beta^-$ ~0.10 p 14.3$^d$ P a
No $\gamma$ a
*Assuming $\sigma[Cl(p,\alpha 2p)Si^{32}] = \sigma[Cl(p,\alpha n2p)Si^{31}]$

M.Lindner, Phys. Rev. 91,642;89,1150(1953).

**$P^{28}$** (15 13)

$\tau$ 0.28$^s$ Si(20-Mev p)
$\beta^+$ scin
$\gamma$ 7
No $\alpha$ (< 10% of $\gamma$)

N.W.Glass, L.K.Jensen, J.R.Richardson, Phys. Rev. 90, 320 (1953).

**$P^{29}$** (15 14)

$\tau$ 4.45$^s$ $Si^{28}$(2.8-Mev d)
$\gamma$ 0.5% (1.28) scin
2.5% (2.43)
(1.28$\gamma$)(0.511$\gamma$) (2.43$\gamma$)(0.511$\gamma$)
No 0.39, 0.76, 1.15, or 2.04$\gamma$

H.Roderick, O.Lönsjö, W.E.Meyerhof, Phys. Rev. 90, 371A(1953).

$\beta^+$ 3.9 Si(8-Mev d) scin

M.Nahmias, T.Yuasa, Compt. rend. 236,2399(1953).

**$P^{30}$** (15 15)

$\tau$ 2.52$^m$ Al($\alpha$,n)

K.Baskova, A.Kudriavtseva, Zhur. Eksptl' i Teoret. Fiz. 23, 483(1952).

**$P^{31}$** (15 16)

Neutron resonances P(n,p)2.6$^h$Si
$E_n$ = 2.05 to 3.25

| | | | |
|---|---|---|---|
| 2.25 | 2.55 | 2.87 | 3.15 |
| 2.37 | 2.70 | 3.02 ? | 3.22 |

I.Nilsson, Trans. Chalmers Univ. Technol., Gothenburg No. 125(1952).

**$P^{32}$** (15 17)

$\tau$ 14.50$^d$ ±0.04 P(pile n)
Counted for 5 half-lives with $\beta$ electroscope
No estimate of $P^{33}$ contamination given

E.E.Lockett, R.H.Thomas, Nucleonics 11, No. 3, 14(1953).

**$P^{32}$** 15 17

$\bar{E}_\beta = 0.694 \pm 0.025$ ic and $4\pi$ counter

J.M.Brabant, L.W.Cochran, R.S.Caswell, Phys. Rev. 90, 340A(1953).

$e^+/e^-$ ($H_\rho$ = 1600) < $10^{-5}$ s

G.W.McClure, Phys. Rev. 91, 483A (1953).

No nuclear $\gamma$ $E_\gamma$ = 0.05-0.9(<$10^{-4}$) scin
From agreement between measured and theoretical bremsstrahlung spectra

W.Goodrich, J.S.Levinger, W.Payne, Phys. Rev. 91, 1225 (1953).

Continuous $\gamma$ spectrum scin
$\gamma(E_\gamma > 0.09)/\beta^- = 0.0023$

P.Bolgiano, L.Madansky, F.Rasetti, Phys. Rev. 89, 679(1953).

| Levels | $P^{31}(d,p)$ | $E_d$ = 14.3 |
|---|---|---|
| d,p($\theta$) | g.s. | $l_n = 2$ |
| | ~1.2 | $l_n = 0$ |

C.F.Black, Phys. Rev. 90, 371A(1953); verbal report.

| Levels | $P^{31}(d,p)$ | $E_d$ = 7.8 pc |
|---|---|---|
| d,p($\theta$) | g.s. | $l_n = 2$ |
| | (0.08) | $l_n = 2$ |
| | (0.52) | $l_n = 0$(22%), 2(78%) |
| | (1.16) | $l_n = 0$(33%), 2(67%) |
| | (1.3) | $l_n = 0$(57%), 2(43%) |

J.S.King, E.H.Beach, Phys. Rev. 90, 381A(1953); verbal report.

| Capture $\gamma$'s | $P^{31}(n,\gamma)$ | 2 crystal scin s |
|---|---|---|
| 37† | 0.51 | |
| 17† | 1.13 | |
| 41† | 2.19 | |

†Photons per 100 n captures

J.T.Braid, Phys. Rev. 90,355A(1953); verbal report.

**$P^{33}$** 15 18

$\tau$ 25$^d$ $S^{33}(n,p)$ chem
$\beta^-$ 0.246 a
No $\gamma$ (<3.5%)

T.Westermark, Phys. Rev. 88, 573(1952).

**$S^{32}$** 16 16

| Level | $S(n,n'\gamma)$ | $E_n$ = 2.5 scin |
|---|---|---|
| $\gamma$ | 2.23 | |

R.B.Day, Phys. Rev. 89, 908A(1953).

| Level | $S(n,n'\gamma)$ | $E_n$ = 14 scin |
|---|---|---|
| $\gamma$ | 2.32 | n'$\gamma$ |

R.E.Garrett, F.L.Hereford, B.W.Sloope, Phys. Rev. 91, 441A (1953); verbal report.

| Levels | $S^{32}(p,p')$ | $E_p$ = 8 s |
|---|---|---|
| | 2.25 4.50 5.04 | |
| | 3.81 4.74 5.83 | |
| | 4.32 | |

J.C.Arthur, A.J.Allen, R.S.Bender, M.J.Hausman, C.J.McDole, Phys. Rev. 88, 1291(1952); 87, 237A (1952).

**$S^{32}$** 16 16

| Resonances | $P^{31}(p,\gamma)$ | $E_p$ = 1.03 to 2.1 |
|---|---|---|
| p,$\gamma(\theta)$ | 1.17 J = 2 ± | scin |
| | 1.27 J = 2 ± | |
| | 1.90 J = 1 - | |

N.E.Gove, E.B.Paul, Phys. Rev. 92, 852 W (1953).

**$S^{33}$** 16 17

| q | -0.050 | S; quad res |
|---|---|---|

H.G.Dehmelt, Phys. Rev. 91, 313 (1953).

| Levels | S(d,p) | $E_d$ = 14.3 |
|---|---|---|
| d,p($\theta$) | g.s. | $l_n = 2$ |
| | (0.79) | $l_n = 0$ |

C.F.Black, Phys. Rev. 90,381A(1953).

| Levels | $S^{32}(d,p)$ | $E_d$ = 8.18 a pc | |
|---|---|---|---|
| d,p($\theta$) | $l_n$ | $d\sigma/d\Omega$† | |
| g.s. | 2 | 7.1 | |
| 0.85 | 0 | 39 | |
| 1.86 | * | 0.8 | |
| 2.28 | * | 1.3 | |
| 2.90 | 3 | 14 | |
| 3.26 | 1 | 83 | |
| 3.91 | — | 1.5 | |
| 4.21 | 1 | 15 | |
| 4.89 | 1 | 9.4 | |
| 5.72 | 1 | 100 | |
| 6.48** | 1and2 | 41 | |
| 7.44 | | | |
| 7.83 | | | |

† Relative at maximum of angular distribution
* Angular distribution isotropic
** Level is a doublet

J.R.Holt, T.N.Marsham, Proc. Phys. Soc. 66A, 467 (1953); Phys. Rev. 89, 665(1953).

| Level | $A^{36}(n,\alpha)$ | $E_n$=2.15 to 4.40 |
|---|---|---|
| | 1.1 ± 0.2 | pc |

B.J.Toppel, S.D.Bloom, Phys. Rev. 91,473A(1953).

| Capture $\gamma$'s | S(n,$\gamma$) | 2 crystal scin s |
|---|---|---|
| 60† | 0.84 | |
| | ~1.52 | |
| 40† | 2.34 | |

†Photons per 100 n captures

J.T.Braid, Phys. Rev. 90,355A(1953); verbal report.

**$Cl^{32}$** 17 15

$\tau$ 0.306$^s$ S(20-Mev p)
$\beta^+$ scin
$\gamma$ 4.8
No $\alpha$ (< 10% of $\gamma$)

N.W.Glass, L.K.Jensen, J.R.Richardson, Phys. Rev. 90, 320 (1953).

**$Cl^{33}$** 17 16

$\beta^+$ 4.2 S(6-Mev d)
scin

M.Nahmias, T.Yuasa, Compt. rend. 236,2399(1953).

**$Cl^{33}$** (17 16)

Levels S(d,n) $E_d$ = 8 ppl
d,n($\theta$)
g.s. $l_p$ = 2
0.76 $l_p$ = 0
~1.89
2.84 $l_p$ = 1
4.22 $l_p$ = 1

R.Middleton, F.A.El-Bedewi, C.T.Tai, Proc. Phys. Soc. 66A, 95(1953).

Resonances $S^{32}(p,p)S^{32}$ $E_p$ = 1.0 to 2.8
p,p($\theta$)
1.90 J=3/2- $\Gamma$ < 0.025
2.31 J=1/2- $\Gamma$ ~ 0.06

A.J.Ferguson, H.E.Gove, Phys. Rev. 91,439A(1953).

**$Cl^{34}$** (17 17)

$\tau_1$ 32.5$^m$ S(p,n)

N.M.Hintz, N.F.Ramsey, Phys. Rev. 88, 19(1952).

**$Cl^{33^m}$**

$\gamma$ IT 0.145 $\alpha$ = 0.16 M3 scin
(0.145$\gamma$)/$\beta^+$ = 0.45 Cl(≤32-Mev $\gamma$)

P.Stähelin, P.Preiswerk, Nuovo Cim. 10, 1219(1953).
W.Arber, P.Stähelin, Helv. Phys. Acta 26,433(1953).

1.5$^s$

$\tau_2$ 1.45$^s$ Cl(≤32-Mev $\gamma$)
$\sigma(1.5^sCl)/\sigma(33^mCl)$ = ~1.7 $E_\gamma$≤16 to $E_\gamma$≤32
4.45 $\beta^+$ assigned to this activity
Conclude 4.45 $\beta^+$ is 0+ ⟶ 0+ (log ft = 3.4)

P.Stähelin, P.Preiswerk, Nuovo Cim. 10,1219(1953).
W.Arber, P.Stähelin, Helv. Phys. Acta 26,433(1953).

**$Cl^{35}$** (17 18)

$\mu$ 0.82111 I
$\nu(Cl^{35})/\nu(Rb^{85})$ = 1.01481 ± 0.00005
$\mu(Cl^{35})/\mu(Cl^{37})$ = 1.20128 ± 0.00006
LiCl, RbCl

Y.Ting, D.Williams, Phys. Rev. 89, 595(1953).

**$Cl^{36}$** (17 19)

Level Cl(d,p) $E_d$ = 6.9
d,p($\theta$)
g.s. $l_n$ = 2

J.S.King, W.C.Parkinson, Phys. Rev. 88, 141(1952).

Capture $\gamma$'s Cl(n,$\gamma$) 2 crystal scin s
0.48 1.85
0.75 2.15
1.14 2.84

J.T.Braid, Phys. Rev. 90,355A(1953); verbal report.

Capture $\gamma$'s Cl(n,$\gamma$) 2 cryst scin s
35† 0.70 14† 2.40
29† 1.12 10† 2.68
19† 1.77 23† 3.71
2.03 4.67

W.A.Reardon, R.W.Krone, R.Stump, Phys. Rev. 91, 334; 91,442A (1953).

Capture $\gamma$'s Cl(n,$\gamma$) scin
0.784 2.00
1.15 6.2
1.59 7.7

B.Hamermesh, V.Hummel, Phys. Rev. 88, 916(1952).

**$Cl^{37}$** (17 20)

$\mu$ 0.68352 I
$\nu(Cl^{37})/\nu(Rb^{85})$ = 0.84477 ± 0.00005
LiCl, RbCl

Y.Ting, D.Williams, Phys. Rev. 89, 595(1953).

A Neutron resonances (Mev) $E_n$=0.4 to 1.1
$\sigma_o$
0.58 ~3.5
0.60 ~3.5
0.74 ~3.5

J.B.Guernsey, C.Goodman, Phys. Rev. 91,440A(1953); verbal report.

**$A^{37}$** (18 19)

$\tau$ 32$^d$ $A^{36}$(pile n)
$E_{dis}$ 0.815 scin a continuous $\gamma$ endpoint

C.E.Anderson, G.W.Wheeler, W.W.Watson, Phys. Rev. 90, 606 (1953).

**$A^{38}$** (18 20)

$A^{36}/A^{38}$ variation of >300% for various pitchblende ores suggests $A^{38}$ formation by $\alpha$'s or fission n's

W.M.Fleming, M.G.Thode, Phys. Rev. 90,857(1953).

**$A^{41}$** (18 23)

$\gamma$ (1.3) $\tau$ = 6.6x10$^{-9}$s $\beta\gamma$

T.C.Engelder, Phys. Rev. 90, 259 (1953).

K Capture $\gamma$'s K(n,$\gamma$) 2 cryst scin
0.77 ($K^{40,42}$) 2.03 ($K^{40}$)
1.19 ($K^{42}$) 2.80
1.61 ~3.45
Assignments from agreement with d,p results

T.H.Braid, Phys. Rev. 91, 442A (1953).

**$K^{40}$** (19 21)

$\beta^-$ 1.4 ± 0.1 $\Delta I$ = 4, yes shape liquid argon ic

J.H.Marshall, Phys. Rev. 91, 905; 90, 371A(1953).

$\epsilon/\beta^-$ = 0.060 ± 0.006 ms of argon 5 samples. Ages from Pb ratios of nearby uraninites. Assumed $\tau_{total}$ = 1.28x10$^9$y

R.D.Russell, H.A.Shillibeer, R.M.Farquhar, A.K. Mousuf, Phys. Rev. 91, 1223(1953); A.K.Mousuf, Phys. Rev. 88, 150 (1952).

$\gamma$'s/sec/gm K = 3.63 ± 0.10 ic

P.R.J.Burch, Nature 172, 361 (1953).

$\Delta M(K^{40} - Ca^{40})$ = 1.30 ± 0.07 Mev ms
$\Delta M(K^{40} - A^{40})$ = 1.49 ± 0.07 Mev

W.H.Johnson, Jr., Phys. Rev. 88, 1213(1952).

Levels K(d,p) $E_d$ = 5.65
0.032 s
0.800
0.893

W.W.Buechner, A.Sperduto, C.P.Browne, C.K.Bockelman, Phys. Rev. 91, 1502 (1953).

**$K^{40}$** 19 21

Capture $\gamma$'s $K(n,\gamma)$ pair s

| | | | | |
|---|---|---|---|---|
| 4† | 4.39 | 4 † | 5.66 | |
| 3† | 5.06 | 6 † | 5.74 | |
| 2† | 5.18 | 1.3† | 6.994 | |
| 8† | 5.38 | 3.5† | 7.757* | |
| 2.5† | 5.50 | | | |

Assignment from agreement with d,p results and intensities

*Intensity indicates goes to 0.032 level

†Photons per 100 n captures in K

G.A.Bartholomew, E.B.Kinsey, Can. J. Phys. 31, 927 (1953).

**$K^{40}$?** 19 21

Capture $\gamma$'s $K(n,\gamma)$ scin

6.0

8.2

B.Hamermesh, V.Hummel, Phys. Rev. 88, 916(1952).

**$K^{41}$** 19 22

Capture $\gamma$'s $K^{40}(n,\gamma)$ pair s

| | | |
|---|---|---|
| 0.10† | 8.45 | enriched $K^{40}$, 0.022% |
| 0.02† | 9.39 | |

†Photons per 100 n capture in K

G.A.Bartholomew, E.B.Kinsey, Can J. Phys. 31, 927 (1953).

**$K^{42}$** 19 23

I 2 M

$\mu$ −1.137

$\Delta F = \pm 1$, $\Delta m = \pm 1$ transitions studied

$\Delta\nu(K^{42}) / \Delta\nu(K^{39}) = 1258.9/461.75$

$\mu(K^{39}) = 0.391$

E.H.Bellamy, K.F.Smith, Phil. Mag. 44, 33(1953).

$\tau$ $12.516^{h} \pm 0.007$ K(pile n) ic

P.R.J.Burch, Nature 172, 361 (1953).

$\tau$ $12.44^{h} \pm 0.08$ K(pile n) chem

$\gamma$ 20% 1.51 scin, ic

No other $\gamma$ observed

B.Kahn, W.S.Lyon, Phys. Rev. 91, 1212(1953).

Capture $\gamma$'s $K(n,\gamma)$ pair s

| | | |
|---|---|---|
| 0.3† | 6.31? | |
| 0.1† | 7.34 | |

Assignment from agreement with d,p results

†Photons per 100 n captures in K

G.A Bartholomew, E.B.Kinsey, Can. J. Phys. 31, 927 (1953).

**Ca** Capture $\gamma$ $Ca(n,\gamma)$ 2 cryst scin

1.93

T.H.Braid, Phys. Rev. 91, 442A(1953).

**$Ca^{39}$** 20 19

$\tau$ $1.00^{s}$ Ca(≤ 25-Mev $\gamma$)

R.G.Summers-Gill, R.N.H.Haslam, L. Katz, Can. J. Phys. 31, 70 (1953).

$\tau$ $1.00^{s}$ Ca(≤ 30-Mev $\gamma$)

$\beta^{+}$ 6.7 a

R.Braams, C.L.Smith, Phys. Rev. 90, 995 (1953).

**$Ca^{40}$** 20 20

Levels $Ca(p,p')$ $E_p$=6.92 to 8.15 s

3.35 3.90

3.71 4.49

C.M.Braams, C.K.Bockelman, C.P.Browne, W.W. Buechner, Phys. Rev. 91,474A (1953);verbal report.

Level $Ca(p,p')$ $E_p = 7.7$ a

3.8

J.A.Harvey, Phys. Rev. 88, 162A(1952).

**$Ca^{41}$** 20 21

Levels $Ca(p,p')$ $E_p = 14.3$

$d,p(\theta)$ g.s. $l_n = 3$

(1.95) $l_n = 1$

C.F.Black, Phys. Rev. 90,381A(1953); verbal report.

Levels $Ca(d,p)$ $E_d$= 8.13 ppl

| $d,p(\theta)$ | $l_{n-}$ | $d\sigma/d\Omega$† |
|---|---|---|
| g.s. | 3 | 3.8 |
| 1.90 | 1 | 23 |
| 2.42 | 1 | 10 |
| 2.9 | | |
| 3.6 | | |
| 3.96 | 2 or 1 | 6 |
| 4.76 | 2 | 7.2 |
| 5.72 | 2 | 7.8 |

†mb/sterad at maximum of angular distribution

J.R.Holt, T.N.Marsham, Proc. Phys. Soc. 66A,565 (1953).

**$Ca^{41}$?** 20 21

Capture $\gamma$'s $Ca(n,\gamma)$ scin

6.8

8.2

B.Hamermesh, V.Hummel, Phys. Rev. 88, 916(1952).

**$Ca^{43}$** 20 23

I 7/2 I

$\mu$ −1.3157

C.D.Jeffries, Phys. Rev. 90, 1130 (1953).

**$Ca^{45}$** 20 25

$\tau$ $164^{d}$ Ca(pile n)

C.F.G.Delaney, J.H.J.Poole, Phys. Rev. 89, 529 (1953).

**$Ca^{47}$** 20 27

$\tau$ $4.8^{d}$

p $3.4^{d}$ Sc Ca(th n)

ion chem

L.G.Cook, K.D.Shafer, Phys. Rev. 90,1121(1953).

**$Ca^{48}$** 20 28

$\tau_{\beta\beta}$ $> 10^{14}$ y ppl

Assuming decay energy ⩾2 Mev

J.H.Fremlin, M.C.Walters, Proc. Phys. Soc. 65A, 911(1952).

**$Sc^{41}$** 21 20

$\tau$ $0.873^{s}$ Ca(30-Mev p) scin

W.W.Martin, S.W.Breckon, Can. J. Phys. 30, 643 (1952)

**$Sc^{43}$** 21 22

$\tau$ $3.95^{h}$ Ca(7-Mev p) chem

J.E.Duval, M.M.Kurbatov, J.Am. Chem. Soc. 75, 2246 (1953).

**$Sc^{43}$** 21 22

| | | | |
|---|---|---|---|
| $\tau$ | | 3.9$^h$ | |
| $\beta^+(+\epsilon)$ | 28% | 0.77 | s |
| | 72% | 1.18 | |
| $\gamma$ | | 0.375 | s pe$^-$ |

Weak 1.15$\gamma$ probably in $Sc^{44}$

$Ca^{43}$(7-Mev p), Ca(20-Mev $\alpha$) chem

J.R.Haskins, J.E.Duval, L.S.Cheng, J.D.Kurbatov, Phys. Rev. 88, 876(1952).

**$Sc^{46}$** 21 25 85$^d$

| | | | | |
|---|---|---|---|---|
| $\beta^-$ | | 0.357 | Sc(pile n) | sm |

F-K plot linear to 0.12

Y.Yoshizawa, J. Phys. Soc. Japan 8, 435 (1953).

| | | | | |
|---|---|---|---|---|
| $\beta^-$ | 0.22% | 1.25 | F-K plot not linear | s |

F.H.Schmidt, G.L.Keister, Phys. Rev. 91,483A (1953).

| | | | |
|---|---|---|---|
| $\beta^-$ | $\leqslant$0.1% | $\leqslant$1.2 | s m |
| $\gamma$ | (0.88) | $\alpha = 1.9 \times 10^{-4}$ | |
| | (1.11) | $\alpha = 0.88 \times 10^{-4}$ | |

J.A.Whalen, F.T.Porter, C.S.Cook, Phys. Rev. 89, 902A(1953).

| | | | |
|---|---|---|---|
| $\gamma$ | (0.88) | $\tau < 2^{\mu s}$ | $\beta\gamma$ |
| | (1.11) | $\tau < 2^{\mu s}$ | $\beta\gamma$ |

S.Kolicki, R.Ballini, R.Chaminade, Compt. rend. 236, 1155(1953).

| | | |
|---|---|---|
| $\gamma$ | 0.885 | Sc(pile n) |
| | 1.119 | s m$\backslash$2 pe$^-$ |

T.Lindquist, Arkiv Fysik 6, 123(1953).

No delayed $\gamma\gamma$ ($\tau < 1.5 \times 10^{-9}$s)

C.E.Whittle, F.T.Porter, Phys. Rev. 90,498(1953).

**$Sc^{46}$** 21 25

| | | | |
|---|---|---|---|
| Level | | $Sc^{45}$(d,p) | $E_d$ = 7.8 pc |
| d,p($\theta$) | | g.s. ? | $l_n$ = 1 ($\leqslant$15%) , 3 ($\geqslant$85%) |

J.S.King, E.H.Beach, Phys. Rev. 90,381A(1953); verbal report.

| | | | |
|---|---|---|---|
| Capture $\gamma$'s | | $Sc^{45}$(n,$\gamma$) | scin |
| | | 0.152 | ($20^s Sc^{46}$) |
| | | 0.220 | |
| | | 7 – 9 | possible lines |

No crossover of 0.152 and 0.220 $\gamma$'s observed

B.Hamermesh, V.Hummel, Phys. Rev. 88, 916(1952).

| | | | | |
|---|---|---|---|---|
| Capture $\gamma$'s | $Sc^{45}$(n,$\gamma$) | | | pair s |
| $2^+$ | 6.35 | $5^+$ | 8.18 | |
| $2.5^+$ | 6.84 | $1^+$ | 8.31 | |
| $0.7^+$ | 7.15 | $2.5^+$ | 8.54 | |
| $1^+$ | 7.65 | $0.3^+$ | 8.85 | |

†Photons per 100 n captures

G.A.Bartholomew, B.B.Kinsey, Phys. Rev. 89, 386 (1953).

**$Sc^{47}$** 21 26

| | | | | |
|---|---|---|---|---|
| $\beta^-$ | ~66% | 0.435 | $Ti^{49}$(10-Mev d) | s l |
| | ~34% | 0.622 | | |

**$Sc^{47}$** 21 26

| | | | |
|---|---|---|---|
| $\gamma$ | | 0.185 | scin |

(0.44$\gamma$) ($\gamma$) No (0.62$\gamma$) ($\gamma$)

L.S.Cheng, M.L.Pool, Phys. Rev. 90,886 (1953).

| | | | |
|---|---|---|---|
| $\tau$ | | 3.44$^d$ | Ca (7-Mev p) chem |

J.E.Duval, M.H.Kurbatov, J. Am. Chem. Soc. 75, 2246 (1953).

**$Sc^{48}$** 21 27

| | | | |
|---|---|---|---|
| $\gamma$ | 100† | (0.98) | scin |
| | 100† | 1.05 | |
| | 100† | (1.33) | |

From comparison with $V^{48}$ No 2.2$\gamma$

M.J.Sterk, A.H.Wapstra, R.E.W.Kropveld, Physica 19, 135 (1953).

| | | | |
|---|---|---|---|
| $\gamma$ | ~100† | 0.99 | scin pe$^-$ |
| | ~100† | 1.32 | |

No 2.29 $\gamma$ (< 0.1†)

M.M.Miller, Phys. Rev. 88, 516(1952).

**Ti** Relative abundances $TiCl_4$; ms

| A | 46 | 47 | 48 | 49 | 50 |
|---|---|---|---|---|---|
| % | 7.87 | 7.25 | 73.9 | 5.56 | 5.43 |

H.C.Mattraw, C.F.Pachucki, AECU – 1903(1952); NSA 6, 2526(1952).

| | | | |
|---|---|---|---|
| Capture $\gamma$'s | Ti(n,$\gamma$) | 2 crystal | scin s |
| 37† | 0.33 | | |
| ~100† | 1.4 | | |

†Photons per 100 n captures

J.T.Braid, Phys. Rev. 90,355A(1953); verbal report

| | | |
|---|---|---|
| Capture $\gamma$'s | Ti(n,$\gamma$) | scin |
| | 1.38 | |
| | 5.0 | |
| | 6.5 – 7.0 | |

B.Hamermesh, V.Hummel, Phys. Rev. 88, 916(1952).

| | | | |
|---|---|---|---|
| Capture $\gamma$ | Ti(n,$\gamma$) | | pair s |
| $1.4^+$ | 4.67 | | |

Isotopic assignment uncertain

†Photons per 100 n captures

B.B.Kinsey, G.A.Bartholomew, Phys. Rev. 89, 375 (1953).

**$Ti^{47}$** 22 25

| | | | |
|---|---|---|---|
| I | | 5/2 | $Ti^{47}Cl_4$ I |
| $\mu$ | | -0.7866 | |

$\nu(Ti^{47})/\nu(Cl^{35}) = 0.57493 \pm 0.00006$

C.D.Jeffries, Phys. Rev. 92,1096A(1953).

| | | | | | |
|---|---|---|---|---|---|
| Levels | | $Ti^{46}$(d,p) | | 82.68% $Ti^{46}$ | pc |
| 10† | g.s. | 17† | 3.09 | | |
| 34† | 1.40 | 50† | 3.70 | | |
| 13† | 2.39 | 50† | 4.18 | | |
| 32† | 2.64 | | | | |

G.F.Pieper, Phys. Rev. 88, 1299(1952).

**$Ti^{48}$** 22 26

| Levels* | $Ti^{47}$(d,p) | 82.05% $Ti^{47}$ | pc |
|---|---|---|---|
| 10† | g.s. | 150† 4.50 | |
| 10† | 1.33 | 180† ~4.9 | |
| <50† | 2.31 | 250† ~5.2 | |
| 100† | 3.31 | | |

*Longest range p group observed may go to first excited and not g.s.

G.F.Pieper, Phys. Rev. 88, 1299(1952).

**$Ti^{48}$?** 22 26

| Capture $\gamma$'s | Ti(n,$\gamma$) | pair s |
|---|---|---|
| 1.5† | 7.38 | |
| 0.4† | 8.27 | |
| 0.1† | 9.39 | |

Assignment assuming n binding = 11.63, 9.39$\gamma$ to 2.31$\beta$ decay level

†Photons per 100 n captures in Ti

B.B.Kinsey, G.A.Bartholomew, Phys. Rev. 89, 375 (1953).

**$Ti^{49}$** 22 27

| | | | |
|---|---|---|---|
| I | 7/2 | $Ti^{49}Cl_4$ | I |
| $\mu$ | -1.102 | | |

$\nu(Ti^{49})/\nu(Cl^{35}) = 0.87508 \pm 0.00006$

C.D.Jeffries, Phys. Rev. 92,1096A(1953).

| Levels | $Ti^{48}$(d,p) | 98.90% $Ti^{48}$ | pc |
|---|---|---|---|
| 10† | g.s. | 40† 2.41 | |
| 90† | 1.35 | 120† 3.11 | |
| 60† | 1.70 | | |

G.F.Pieper, Phys. Rev. 88, 1299(1952).

| Capture $\gamma$'s | Ti(n,$\gamma$) | pair s |
|---|---|---|
| 5† | 4.88 | |
| 3.5† | 4.96 | |
| 0.4† | 5.65 ($Ti^{49}$?) | |
| 32† | 6.412 | |
| 4† | 6.53 | |
| 53† | 6.756 (also $Ti^{50}$?) | |

Assignment from agreement with d,p results; see also Ti

†Photons per 100 n captures in Ti 89, 375

B.B.Kinsey, G.A.Bartholomew, Phys. Rev. 89, 375 (1953).

**$Ti^{50}$** 22 28

| Levels | $Ti^{49}$(d,p) | 77.27% $Ti^{49}$ | pc |
|---|---|---|---|
| 10† | g.s. | 240† 4.88 | |
| 10† | 1.58 | 190† 5.39 | |
| <10† | 3.0 | 330† 5.99 | |
| 240† | 4.14 | | |

G.F.Pieper, Phys. Rev. 88, 1299(1952).

**$Ti^{50}$?** 22 28

| Capture $\gamma$'s | Ti(n,$\gamma$) | pair s |
|---|---|---|
| 53† | 6.756 (also $Ti^{49}$) | |
| 0.8† | 7.80 | |
| 0.2† | 9.19 | |

Assignment assuming n binding = 10.8, 9.19$\gamma$ to 1.58 d,p level

†Photons per 100 n captures in Ti

B.B.Kinsey, G.A.Bartholomew, Phys. Rev. 89, 375 (1953).

**$Ti^{51}$** 22 29

$\tau$ 5.79$^m$ ± 0.03 Ti(pile n)

Counted for 8 half-lives in $\beta$ electroscope

B.W.Sargent, L.Yaffe, A.P.Gray, Can. J. Phys. 31, 235(1953).

**$Ti^{51}$** 22 29

$\tau$ 5.9$^m$

Mass assignment confirmed by $Ca^{48}$(20-Mev $\alpha$), $Ti^{50}$(slow n), $Cr^{54}$(fast n), $V^{51}$(fast n)

W.R.Hammond, D.N.Kundu, M.L.Pool, Phys. Rev. 90, 157(1953).

| | | | | |
|---|---|---|---|---|
| $\beta^-$ | 80% | 1.9 | V(n) Ti(d) | chem; a,s |
| | 20% | 2.2 | | |
| $\gamma$ | | 0.32 | | scin |

(1.9$\beta$) (0.32$\gamma$)

L.Koester, H.Maier-Leibnitz, T.Mayer-Kuckuk, K.Schmeiser, G.Schulze-Pillot, Z. Phys. 133, 319(1952).

| Levels | $Ti^{50}$(d,p) | 84.69% $Ti^{50}$ | pc |
|---|---|---|---|
| 10† | g.s. | 8† { 1.15? | |
| 3† | 0.61 | { 1.6? | |

G.F.Pieper, Phys. Rev. 88, 1299(1952).

No long lived $Ti^{51}$ activity from Ti(th n),ms
Activity in Ti foil due to $Ta^{182}$, chem

W.Forsling, A.Ghosh, Arkiv Fysik 4, 331(1951).

**$V^{46}$** 23 23

| | | | |
|---|---|---|---|
| $\tau$ | 0.40$^s$ | Ti(15-Mev p) | |
| $\beta^+$ | ~6 | scin bias | |

W.M.Martin, S.W.Breckon, Can. J. Phys. 30, 643 (1952).

**$V^{48}$** 23 25

| | | | |
|---|---|---|---|
| $\tau$ | 16.4$^d$ | | |
| (1.32$\gamma$) (0.99$\gamma$) ($\epsilon$) | | I = 4,2,0 | |

P.Meyer, S.Schlieder, Z. Phys. 135, 119 (1953).

| | | | | |
|---|---|---|---|---|
| $\beta^+$ | ~95† | 0.69 | $Sc^{45}$($\alpha$,n) | chem; s$\pi$ |
| | ~5† | ~0.82 | | |
| $\gamma$ | | (0.99) | | scin |
| | 100† | (1.32) | | |
| | 2† | (2.22) | | |

(0.511$\gamma$) (1.32$\gamma$,0.99$\gamma$,2.2$\gamma$)
(1.32$\gamma$) (0.99$\gamma$) No(0.99$\gamma$) (2.2$\gamma$) No(1.32$\gamma$) (2.2$\gamma$)
$\gamma\gamma(\theta)$ indicates I = 4, 2, 0

No ce$^-$ between 0.070 and 0.12

P.L.Roggenkamp, C.H.Pruett, R.G.Wilkinson, Phys. Rev. 88, 1262(1952).

| | | | |
|---|---|---|---|
| $\gamma$ | ~100† | 0.99 | scin |
| | ~100† | 1.32 | |
| | 1.7† | 2.29 | |

(0.511$\gamma$,1.32$\gamma$) (0.99$\gamma$)
(0.511$\gamma$) (1.32$\gamma$,2.2$\gamma$)

M.M.Miller, Phys. Rev. 88, 516(1952).

| | | | |
|---|---|---|---|
| $\gamma$ | 0.98 | | scin |
| | 1.33 | | |
| | 2.22 ± 0.10 | | |

$\epsilon/\beta^+ = 0.48$

M.J.Sterk, A.H.Wapstra, R.E.W.Kropveld, Physica 19, 135 (1953).

| | | | |
|---|---|---|---|
| $\gamma$ | (0.99) | $\tau < 2 \times 10^{-9}$s | $\beta\gamma$ |
| | (1.32) | $\tau < 2 \times 10^{-9}$s | $\beta\gamma$ |

T.C.Engelder, Phys. Rev. 90, 259 (1953).

**$V^{50}$** 23 27

$\tau_{\beta\epsilon}$ $> 10^{12}$ y

S.G.Cohen, Bull. Research Council Israel 2, 195 (1952).

I 6 para

J.M.Baker, B.Bleaney, Proc. Phys. Soc. 65A, 952 (1952).

I 6 para

C.Kikuchi, M.H.Sirvetz, V.W.Cohen, Phys. Rev. 88, 142(1952); 92, 109(1953).

**$V^{51}$** 23 28

I 7/2 para

C.Kikuchi, M.H.Sirvetz, V.W.Cohen, Phys. Rev. 88, 142(1952); 92, 109(1953).

| Levels | V(p,p′) | | $E_p$ = 8 | s |
|---|---|---|---|---|
| | 0.33 | 2.43 | 3.83 | |
| | 0.48 | 2.65 | 3.96 | |
| | 1.16 | 3.11 | 4.90 | |
| | 1.84 | 3.41 | 4.97 | |
| | 2.22 | 3.58 | | |

No level at 0.287 by (p,p)

H.J.Hausman, A.J.Allen, J.S.Arthur, R.S.Bender, C.J.McDole, Phys. Rev. 88, 1296(1952).

**$V^{51}$ ?** 23 28

| Capture γ's | V(n,γ) | pair s |
|---|---|---|
| $0.3^{+}$ | 7.67 | |
| $1.3^{+}$ | 7.83 | |
| $0.5^{+}$ | 7.96 | |

$E_\gamma$ greater than $V^{51}$ n binding

γ intensity implies $\sigma_a(V^{50})$ = 40 - 400

$^{+}$Photons per 100 n captures in V

G.A.Bartholomew, B.B.Kinsey, Phys. Rev. 89, 386 (1953).

**$V^{52}$** 23 29 $16^h$

| | | | | |
|---|---|---|---|---|
| $\tau_1$ | $16^h$ | | V(pile n) | |
| γ | 0.059 | 0.85 | 1.76 | scin |
| | 0.096 | 1.00 | 2.33 | |
| | 0.539 | 1.40 | 3.2 | |
| | 0.74 | | | |

T.Wiedling, Phys. Rev. 91, 767 (1953).

**$V^{52}$** 23 29

$\tau_2$ $3.76^m \pm 0.02$ $V^{51}$(pile n)

Counted for 5 half-lives in β electroscope

B.W.Sargent, L.Yaffe, A.P.Gray, Can. J. Phys. 31, 235(1953).

| Levels | $V^{51}$(d,p) | $E_d$ = 7.8 | pc |
|---|---|---|---|
| d,p(θ) | g.s. | $l_n = 1 (\geq 75\%)$, $3 (\leq 25\%)$ | |
| | (0.79) | $l_n = 1$ | |
| | (1.6) | $l_n = 1$ | |

J.S.King, W.C.Parkinson, Phys. Rev. 89,1080; 90,318A(1953).

| Capture γ's | V(n,γ) | | | pair s |
|---|---|---|---|---|
| $2^{+}$ | 3.39 | $10^{+}$ | 5.511 | |
| $3^{+}$ | 3.59 | $9^{+}$ | 5.744 | |
| $3^{+}$ | 3.73 | $3^{+}$ | 5.88 | |
| $4^{+}$ | 4.15 | $25^{+}$ | 6.508 | |
| $3^{+}$ | 4.45 | $0.7^{+}$ | 6.62 | |
| $2^{+}$ | 4.85 | $14^{+}$ | 6.868 | |
| $2^{+}$ | 4.98 | $18.5^{+}$ | 7.154 | |

**$V^{52}$** 23 29

$6^{+}$ 5.21 $11^{+}$ 7.305

$^{+}$Photons per 100 n captures in V

G.A.Bartholomew, B.B.Kinsey, Phys. Rev. 89, 386 (1953).

| Capture γ's | V(n,γ) | | scin |
|---|---|---|---|
| | 5.3 | 6.8 | |
| | 5.7 | 7.4 | |

B.Hamermesh, V.Hummel, Phys. Rev. 88, 916(1952).

**Cr** Levels

| Cr(p,p′) | | $E_p$ = 8 | s |
|---|---|---|---|
| 0.48 | 3.20 | 3.80 | |
| 0.81 | 3.46 | 3.99 | |
| 2.69 | 3.51 | 4.07 | |
| 2.79 | 3.65 | 4.78 | |

H.J.Hausman, A.J.Allen, J.S.Arthur, R.S.Bender, C.J.McDole, Phys. Rev. 88, 1296(1952).

| Capture γ's | Cr(n,γ) | | | pair s |
|---|---|---|---|---|
| $0.5^{+}$ | 3.72 | $3.0^{+}$ | 6.644 | |
| $0.8^{+}$ | 4.83 | $0.8^{+}$ | 6.872 | |
| $1^{+}$ | 5.26 | $2.8^{+}$ | 7.097 | |
| $2^{+}$ | 5.61 | $0.2^{+}$ | 7.21 | |
| $1^{+}$ | 6.00 | $0.2^{+}$ | 7.54 | |
| $0.7^{+}$ | 6.12 | $0.2^{+}$ | 7.67 | |
| $0.9^{+}$ | 6.26 | $7^{+}$ | 8.499 | |
| $0.3^{+}$ | 6.358 | | | |

Isotopic assignment uncertain

$^{+}$Photons per 100 n captures

B.B.Kinsey, G.A.Bartholomew, Phys. Rev. 89, 375 (1953).

| Capture γ's | Cr(n,γ) | | scin |
|---|---|---|---|
| | 0.880 | 8.0 - 8.5 | |
| | 5 - 6 | 8.5 - 9.0 | |

Spectrum very complex at high energies

B.Hamermesh, V.Hummel, Phys. Rev. 88, 916(1952).

**$Cr^{49}$** 24 25

| | | | | |
|---|---|---|---|---|
| τ | | $41.7^m$ | Ti(40-Mev α) | |
| $\beta^{+}$ | $15^{+}$ | 0.73 | chem | sl |
| | $35^{+}$ | 1.39 | | |
| | $50^{+}$ | 1.54 | | |
| γ | 0.153 | $\alpha_K$ = 0.02 M1 | ce;$pe^{-}$ | |
| | 0.609 | $\alpha_K$ = < 4 x $10^{-4}$ | $pe^{-}$ | |

No 0.782 γ

B.Crasemann, H.T.Easterday, Phys. Rev. 90,1124 (1953).

**$Cr^{51}$** 24 27

γ 0.330 pc

No lower energy γ

A.L.Cockroft, quoted by S.C.Curran, Physica 18, 1161(1953).

γ 21% (0.32) $\alpha_K$ = 0.0015 M1 pc, scin

No 0.267 γ

D.Maeder, P.Preiswerk, A.Steinemann, Helv. Phys. Acta 25, 461(1952).

**$Cr^{52}$** 24 28

Level Cr(n,n′γ) $E_n$ = 3.7 scin

γ 1.43

Level also by n,n′

Assignment from agreement with $Mn^{52}$ decay

M.A.Rothman, D.W.Kent, C.E.Mandeville, J.Franklin Inst. 256,278(1953); Phys. Rev. 92,1097A(1953).

**$Cr^{52}$** (24 28)

Levels Cr(p,p') $E_p$ = 8 s

| | | |
|---|---|---|
| 1.45 | | |
| 2.43 | | |
| 2.99 | | |

Assignment from agreement with $Mn^{52}$ decay

H.J.Hausman, A.J.Allen, J.S.Arthur, R.S.Bender, C.J.McDole, Phys. Rev. 88, 1296(1952).

**$Cr^{53}$** (24 29)

I 3/2 para

$|\mu|$ 0.58

K.D.Bowers, Proc. Phys. Soc. 65A, 860(1952).

$\mu$ -0.47362 $Na_2CrO_4$ I

$\nu(Cr^{53})/\nu(D)$ = 0.36820 ± 0.00003 90% $Cr^{53}$

C.D.Jeffries, P.B.Sogo, Phys. Rev. 91,1286(1953).

$\mu$ -0.47351 I

$\nu(Cr^{53})/\nu(N^{14})$=0.78228±0.00005 $Na_2CrO_4$

F.Alder, K.Halbach, Helv. Phys. Acta 26,426(1953).

Level Cr(d,p) $E_d$ = 14.3

d,p($\theta$) g.s. $l_n$ = 1

C.F.Black, Phys. Rev. 90, 381A(1953).

Levels $Cr^{52}$(d,p) $E_d$ = 10.2 ppl

| | | |
|---|---|---|
| 0.54 | 3.20 | |
| 0.97 | 3.65 | |
| 1.29 | 4.10 | |
| 2.66 | | |

C.E.McFarland, M.M.Bretscher, F.B.Shull, Phys. Rev. 89, 892A(1953).

Capture $\gamma$'s Cr(n,$\gamma$) pair s

| | | |
|---|---|---|
| $3^+$ | 7.364 | |
| $8^+$ | 7.929 | |

Assignment from agreement with d,p results;
see also Cr
†Photons per 100 n captures in Cr

B.B.Kinsey, G.A.Bartholomew, Phys. Rev. 89, 375 (1953).

**$Cr^{53?}$** (24 29)

23 $\alpha$ tracks from Fe(th n) $E_\alpha \sim 5$ ppl

J.P.Lonchamp, J. phys. radium 13, 333(1952).

No reaction Fe(th n,$\alpha$) $\sigma < 10^{-5}$ ppl

H.Faraggi, J. phys. radium 14, 160(1953).

**$Cr^{54}$** (24 30)

$\tau_{\beta\beta}$ $> 6 \times 10^{15}$ y ppl

Assuming decay energy $\geq$2 Mev

J.H.Fremlin, M.C.Walters, Proc. Phys. Soc. 65A, 911(1952).

Capture $\gamma$'s Cr(n,$\gamma$) pair s

| | | |
|---|---|---|
| $19^+$ | 8.881 | |
| $7^+$ | 9.716 | |

Assignment from masses and $Mn^{54}$ 0.835$\gamma$;
see also Cr
†Photons per 100 n captures in Cr

B.B.Kinsey, G.A.Bartholomew, Phys. Rev. 89, 375 (1953).

**$Cr^{54?}$** (24 30)

Capture $\gamma$ Cr(n,$\gamma$) 2 cryst scin

0.83 see also Cr

T.H.Braid, Phys. Rev. 91, 442A (1953).

**$Cr^{55}$** (24 31)

$\tau$ 3.52$^m$ Cr(n,$\gamma$) Mn(n,p) chem

$\beta^-$ 2.85 a

No $\gamma$ (< 10%)

A.Flammersfeld, W.Herr, Z. Naturforsch. 7a, 649 (1952).

**$Mn^{50}$** (25 25)

$\tau$ 0.28$^s$ Cr(17-Mev p)

$\beta^+$ ~6.3 scin bias

W.W.Martin, S.W.Breckon, Can. J. Phys. 30, 643 (1952).

**$Mn^{55}$** (25 30)

Q ~0.5 Mic

A.Javan, G.Silvey, C.H.Townes, A.V.Grosse, Phys. Rev. 91,222A(1953).

Levels $Mn^{55}$(p,p') $E_p$ = 8 s

| | | |
|---|---|---|
| 0.13 | 2.27 | 3.05 |
| 1.00 | 2.42 | 3.21 |
| 1.30 | 2.59 | 3.31 |
| 1.56 | 2.77 | 3.42 |
| 1.91 | 2.85 | 3.64 |

H.J.Hausman, A.J.Allen, J.S.Arthur, R.S.Bender, C.J.McDole, Phys. Rev. 88, 1296(1952).

**$Mn^{56}$** (25 31)

$\tau$ 2.576$^h$ ± 0.002 Mn(th n)

Counted for 11 half-lives 4$\pi$ counter

R.M.Bartholomew, R.C.Hawkins, W.F.Merritt, L.Yaffe, Can. J. Chem 31, 204(1953).

$\tau$ 2.581$^h$ ± 0.003 Mn(pile n)

Counted 2 samples each for 10 half-lives with automatic recording $\beta$ electroscope

R.M.Bartholomew, F.Brown, W.D.Howell, W.R.J.Shorey, L.Yaffe , Can. J. Phys. 31, 714 (1953).

$\tau$ 2.574$^h$ ± 0.003 Mn(pile n)

Counted for 4 half-lives with $\beta$ electroscope

E.E.Lockett, R.H.Thomas, Nucleonics 11, No. 3, 14(1953).

$\gamma$ (0.85) $\tau < 2 \times 10^{-9}$ s $\beta\gamma$

T.C.Engelder, Phys. Rev. 90, 259 (1953).

$\gamma$ 100† 1.81 $\alpha_{pair} = 5.6 \times 10^{-4}$ E1 sl

100† 2.13 $\alpha_{pair} = 4.6 \times 10^{-4}$ E2? $pe^-$

H.Slätis, K.Siegbahn, Arkiv Fysik 4, 485(1952).

Capture $\gamma$'s $Mn^{55}$(n,$\gamma$) scin

| | |
|---|---|
| 0.090 | 5.0 |
| 0.190 | 7.2 |

No crossover of 0.090 and 0.190 $\gamma$'s observed

B.Hamermesh, V.Hummel, Phys. Rev. 88, 916(1952).

Capture $\gamma$'s $Mn^{55}$(n,$\gamma$) pair s

| | | | |
|---|---|---|---|
| $1^+$ | 3.82 | $0.3^+$ | 5.63 |
| $1^+$ | 4.10 | $1^+$ | 5.77 |
| $2^+$ | 4.24 | $0.5^+$ | 5.91 |

$Mn^{56}$ 25 31

| | | | |
|---|---|---|---|
| $2^+$ | 4.55 | $1^+$ | 6.11 |
| $2^+$ | 4.72 | $0.5^+$ | 6.43 |
| $2^+$ | 4.81 | $2.5^+$ | 6.779 |
| $6^+$ | 5.04 | $6.5^+$ | 7.048 |
| $3^+$ | 5.21 | $4^+$ | 7.15 |
| $4^+$ | 5.53 | $12^+$ | 7.261 |

†Photons per 100 n captures

G.A.Bartholomew, B.B.Kinsey, Phys. Rev. 89, 386 (1953).

Fe $\gamma$'s Fe(n,n'$\gamma$) $E_n$ = 14 scin n'$\gamma$

0.85
1.29
1.42
2.1

R.E.Garrett, F.L.Hereford, B.W.Sloope, Phys. Rev. 91, 441A (1953); verbal report.

$\gamma$'s Fe(n,n'$\gamma$) $E_n$ = 14 scin n'$\gamma$

3.3
4.4
5.8
7.1
8.75

Spectrum continuous below 3 Mev

V.E.Scherrer, R.Theus, W.R.Faust, Phys. Rev. 89, 1268(1953).

Capture $\gamma$'s Fe(n,$\gamma$)

0.425
8.5

Isotopic assignment uncertain

B.Hamermesh, V.Hummel, Phys. Rev. 88, 916(1952).

Capture $\gamma$'s Fe(n,$\gamma$) pair s

| | | |
|---|---|---|
| $2.0^+$ | 3.43 | |
| $0.5^+$ | 3.86 | |
| $2^+$ | 4.21 | |
| $1^+$ | 4.44 | |
| $1^+$ | 4.81 | |
| $0.4^+$ | 6.369 | |

Isotopic assignment uncertain

†Photons per 100 n captures

B.B.Kinsey, G.A.Bartholomew, Phys. Rev. 89, 375 (1953).

$Fe^{55}$ 26 29

$E_{dis}$ 0.20 scin
from continuous $\gamma$ endpoint

P.Bolgiano, L.Madansky, F.Rasetti, Phys. Rev. 89, 679(1953).

$E_{dis}$ 0.22 scin
from continuous $\gamma$ endpoint

A.Michalowicz, J. phys. radium 14, 214(1953).

(K x ray)(K x ray) in ~0.04% of disintegrations from double ionization of K shell pc

G.Charpak, Compt. rend. 237, 243 (1953).

No $e^-$ ($< 6 \times 10^{-5}$%) between 0.030 and 0.20 $Mn^{55}$ (10-Mev d,2n) chem

F.T.Porter, M.P.Motz, Phys. Rev. 89, 938(1953).

$Fe^{55}$ 26 29

Capture $\gamma$'s Fe(n,$\gamma$) pair s

| | | |
|---|---|---|
| $0.8^+$ | 8.345 | |
| $0.5^+$ | 8.872 | |
| $2.7^+$ | 9.298 | (also $Fe^{58}$ ?) |

Assignment from agreement with d,p and p,n results;see also Fe

†Photons per 100 n captures in Fe

B.B.Kinsey, G.A.Bartholomew, Phys. Rev. 89, 375 (1953).

$Fe^{56}$ 26 30

$\gamma$ Fe(n,n'$\gamma$) $E_n$ = 3.7 scin

0.88

M.A.Rothman, D.W.Kent, C.E.Mandeville, J.Franklin Inst. 256, 278 (1953). Phys. Rev. 92, 1097A(1953).

$\gamma$ Fe(n,n'$\gamma$) $E_n$ = 2.4 scin

(0.85)

W.J.Poole, Phil. Mag. 43, 1060(1952).

$\gamma$ Fe(n,n'$\gamma$) $E_n$ = 1.23 scin

(0.85)

B.Rose, J.M.Freeman, Proc. Phys. Soc. 66A, 120 (1953).

$\gamma$'s Fe(n,n'$\gamma$) $E_n$ = 14 scin

0.85
1.25

L.C.Thompson, Phys. Rev. 89, 905A(1953).

$\gamma$'s Fe(n,n'$\gamma$) $E_n$ = 2.5 scin

0.85
1.25
1.42 ($Fe^{57}$?)

R.B.Day, Phys. Rev. 89, 908A(1953).

$Fe^{57}$ 26 31

$|\mu|$ <0.05 para

R.S.Trenam, Proc. Phys. Soc. 66A,414 (1953).

Levels Fe(d,p) $E_d$ = 14.3
d,p($\theta$)

| | |
|---|---|
| g.s. | $l_n = 1$ |
| ~1.4 | $l_n = 1$ |
| ~2.6 | $l_n = 1$ |

C.F.Black, Phys. Rev. 90, 381A(1953).

Capture $\gamma$'s Fe(n,$\gamma$) pair s

| | |
|---|---|
| $0.5^+$ | 4.968 |
| $5.2^+$ | 5.914 |
| $5.6^+$ | 6.015 |
| $3.5^+$ | 7.285 |
| $36^+$ | 7.639 |

Assignment from agreement with d,p results; see also Fe

†Photons per 100 n captures in Fe

B.B.Kinsey, G.A.Bartholomew, Phys. Rev. 89, 375(1953).

Capture $\gamma$'s Fe(n,$\gamma$)

6.0
7.4

Assignment from intensities
No line at 1.4 observed

B.Hamermesh, V.Hummel, Phys. Rev. 88, 916(1952).

**$Fe^{58}$** 26 32

$\tau_{\beta\beta}$ $>3 \times 10^{14}$ y ppl
Assuming decay energy $\geq$2 Mev

J.H.Fremlin, M.C.Walters, Proc. Phys. Soc. 65A, 911(1952).

Capture $\gamma$'s Fe(n,$\gamma$) pair s
2.7† 9.298 (also $Fe^{55}$ ?)
0.1† 10.16
Assignment from masses and $Co^{58}$ decay;
‡see also Fe
†Photons per 100 n captures in Fe

B.B.Kinsey, G.A.Bartholomew, Phys. Rev. 89, 375(1953).

**$Fe^{59}$** 26 33

| | | | | |
|---|---|---|---|---|
| $\beta^-$ | 48% | 0.271 | F-K plot linear | sl |
| | 54% | 0.462 | F-K plot linear | |
| | 0.3% | 1.560 | F-K plot not $\alpha$ or $D_2$ | |
| $\gamma$ | 2.8% | 0.191 | $\alpha = 7 \times 10^{-3}$ | M1 |
| | 57% | 1.098 | $\alpha = 1.8 \times 10^{-4}$ | M1 |
| | 43% | 1.289 | $\alpha = 1.4 \times 10^{-4}$ | E2 |

(0.19$\gamma$)(1.1$\gamma$) $Fe^{58}$(pile n,$\gamma$); sl ce$^-$ pe$^-$
$\gamma\gamma(\theta)$ agrees with I = 3/2, 5/2, 7/2 scin

F.R.Metzger, Phys. Rev. 88, 1360(1952).

$\gamma\gamma$ ($\theta$) scin
Agrees with I = 3/2, 5/2, 7/2
Excludes I = 5/2, 3/2, 7/2

D.Schiff, F.H.Metzger, Phys. Rev. 90, 849 (1953)L

| | | | |
|---|---|---|---|
| $\gamma$ | $58^+$ | 1.10 | s $\pi$ cpt |
| | $42^+$ | 1.28 | |

No other $\gamma$ (0.5 to 2.1) < 10%

B.S.Dzhelepov, N.N.Zhukovskii, Y.V.Khol'nov, Doklady Akad. Nauk SSSR 86, 497(1952).

| | | | |
|---|---|---|---|
| $\gamma$ | (1.10) | $\alpha = 1.8 \times 10^{-4}$ | s ce$^-$ |
| | (1.30) | $\alpha = 1.1 \times 10^{-4}$ | |

G.Hinman, D.Brower, R.Leamer, Phys. Rev. 90, 370A(1953).

**Co** Neutron resonance $E_n$ = 1 ev to 5 kev
123 ev $\sigma_o\Gamma^2 = 2.1 \times 10^5$

A.W.Merrison, E.R.Wiblin, Proc. Roy. Soc. 215A, 278(1952).

**$Co^{54}$** 27 27

| | | |
|---|---|---|
| $\tau$ | ~0.18$^s$ | Fe(17-Mev p) |
| $\beta^+$ | ~7.4 | scin bias |

W.M.Martin, S.W.Breckon, Can. J. Phys. 30, 643 (1952).

**$Co^{56}$** 27 29

| | | | | |
|---|---|---|---|---|
| $\beta^+$ | ~3† | 0.995 | $Mn^{55}$(20-Mev $\alpha$) | chem; s |
| $\beta^+$ | ~8† | 1.53 | | |

L.S.Cheng, J.L.Dick, J.D.Kurbatov, Phys. Rev. 88, 887(1952).

**$Co^{57}$** 27 30

| | | |
|---|---|---|
| I | 7/2 | para |
| $\mu$ | 4.6 | |

J.M.Baker, B.Bleaney, K.D.Bowers, P.F.D.Shaw, R.S.Trenam, Proc. Phys. Soc. 66A, 305(1953).

**$Co^{57}$** 27 30

| | | | | |
|---|---|---|---|---|
| $\beta^+$ | 0.320 | $Mn^{55}$(20-Mev $\alpha$) | | chem; s |
| $\gamma$ | | $\alpha_K$ | K/L | |
| | <0.018 | | | s ce$^-_L$ |
| | 0.119 | ~0.7 | ~6.3 M2,E3 | ce$^-$ |
| | 0.133 | ~0.7 | ~5.2 E3 | pe$^-$ |

L.S.Cheng, J.L.Dick, J.D.Kurbatov, Phys. Rev. 88, 887(1952).

**$Co^{58}$** 27 31 72$^d$

| | | |
|---|---|---|
| $\|\mu\|$ | 3.5* | $\gamma(\theta,T)$ |
| 0.805$\gamma$ is not dipole | | $\gamma(\theta,T)$ |

*Based on I = 2

J.M.Daniels, M.A.Grace, H.Halban, N.Kurti, F.N.H. Robinson, Phil. Mag. 43, 1297(1952).

$\tau_2$ 72$^d$ d 9.2$^h$Co chem

D.C.Hoffman, D.S.Martin Jr., J. Phys. Chem. 56, 1097(1952).

| | | | |
|---|---|---|---|
| $\beta^+$ | 0.472 | $Mn^{55}$(20-Mev $\alpha$) | chem; s |
| $\gamma$ | (0.805) | $\alpha_K = 2.9 \times 10^{-4}$ | E2 ce$^-$,pe$^-$ |

L.S.Cheng, J.L.Dick, J.D.Kurbatov, Phys. Rev. 88, 887(1952).

$\gamma$ (0.805) Electric multipole
Polarization from low temp. aligned nuclei

G.R.Bishop, J.M.Daniels, G.Goldschmidt, H.Halban, N.Kurti, F.N.H.Robinson, Phys. Rev. 88, 1432 (1952).

**$Co^{59}$** 27 32

| | | | |
|---|---|---|---|
| Level | Co(n,n'$\gamma$) | $E_n$= 2.7 | |
| $\gamma$ | 1.1 | | scin |

V.E.Scherrer, W.L.Smith, B.A.Allison, W.R.Faust, Phys. Rev. 91, 768 (1953).

**$Co^{60}$** 27 33 10.7$^m$

$\tau_1$ 10.47$^m$ ± 0.02 Co(pile n)
Counted 6 samples each for 7 half-lives

R.M.Bartholomew, F.Brown, W.D.Howell, W.R.J.Shorey L.Yaffe, Can. J. Phys. 31, 714 (1953).

$\gamma$ 0.059 $\alpha_K$ = 35 pc, scin

J.H.Kahn, ORNL-1089(1951).

5.2$^y$ $|\mu|$ 3.5 $\gamma(\theta,T)$
Value of 3.0 (Phys. Rev. 85, 688.) in error

B.Bleaney et al., quoted by J.M.Daniels et al., Phil. Mag. 43, 1297(1952).

$\tau_2$ 4.95$^y$ ± 0.04 Co(pile n)
Counted for 8 months with $\beta$ electroscope

E.E.Lockett, R.H.Thomas, Nucleonics 11, No. 3, 14(1953).

$\tau_2$ 5.21$^y$ ± 0.04
Counted for 3 years with ic

J.Kastner, G.N.Whyte, Phys. Rev. 91, 332 (1953).

$\beta^-$ 0.316 Co(pile n) s$\pi$

Y.Yoshizawa, J. Phys. Soc. Japan, 8, 435(1953).

**$Co^{60}$** 27 33 $5.2^{y}$

| | | | | |
|---|---|---|---|---|
| $\gamma$ | 1.1728 | K/LM~10 | sπ | $ce_K^-$ |
| | 1.3325 | K/LM~10 | | |

Energy calibration from authors' new absolute measurement of 1.12 and 1.41 $\gamma$'s of $Bi^{214}$

G.Lindström, A. Hedgran, D.E.Alburger, Phys. Rev. 89, 1303(1953).

| | | | |
|---|---|---|---|
| $\gamma$ | (1.17) | $\tau < 2 \times 10^{-9}$s | $\beta\gamma$ |
| | (1.33) | $\tau < 2 \times 10^{-9}$s | $\beta\gamma$ |

T.C.Engelder, Phys. Rev. 90, 259 (1953).

| | | |
|---|---|---|
| $\gamma$ | (1.17) | Electric multipole |
| | (1.33) | Electric multipole |

Polarization from low temp. aligned nuclei

G.R.Bishop, J.M.Daniels, G.Goldschmidt, H.Halban, N.Kurti, F.N.H.Robinson, Phys. Rev. 88, 1432 (1952).

$(1.17\gamma)/(1.33\gamma) = 0.98 \pm 0.04$ sπ Cpt

B.S.Dzhelepov et al, Doklady Akad. Nauk USSR 77, 233(1951); NSA 5, 6510(1951).

$\gamma\gamma(\theta)$, $\gamma\gamma$ polarization-direction scin
I = 4+, 2+, 0+

R.M.Kloepper, E.S.Lennox, M.L.Wiedenbeck, Phys. Rev. 88, 695(1952).

$\gamma\gamma(\theta)$, $\gamma\gamma$ polarization-direction
I = 4+, 2+, 0+

J.J.Kraushaar, M.Goldhaber, Phys. Rev. 89, 1081 (1953).

$\gamma\gamma(\theta)$ I=4,2,0 b= 0.167

J.S.Lawson, Jr., H.Frauenfelder, W.K.Jentschke, Phys. Rev. 91, 484A; 91, 649 (1953).

$\gamma\gamma(\theta)$ I=4,2,0 b= 0.168

S.Chatterjee, A.K.Saha, Z.Phys. 135, 141 (1953).

$\gamma\gamma(\theta)$ depends on chemical state

E.D.Klema, F.K.McGowan, Phys. Rev. 91, 616(1953).

**$Co^{60}$** 27 33

Capture $\gamma$'s $Co(n,\gamma)$ scin

| | |
|---|---|
| 0.220 | 5.8 |
| 1.1 | 7.0 |
| 1.5 | |

B.Hamermesh, V.Hummel, Phys. Rev. 88, 916(1952).

Capture $\gamma$'s $Co(n,\gamma)$ 2 cryst scin s

| | |
|---|---|
| 100† | 0.52 |
| 19† | 1.30 |
| 20† | 2.00 |
| | 2.39? |
| 19† | 3.58 |

W.A.Reardon, R.W.Krone, R.Stump, Phys. Rev. 91, 334; 91, 442A (1953).

Capture $\gamma$'s $Co^{59}(n,\gamma)$ pair s

| | | | |
|---|---|---|---|
| $1^+$ | 3.36 | $5.6^+$ | 5.966 |
| $0.7^+$ | 3.69 | $0.5^+$ | 6.11 |
| $1^+$ | 4.03 | $0.7^+$ | 6.250 |

**$Co^{60}$** 27 33

| | | | |
|---|---|---|---|
| $0.8^+$ | 4.18 | $5^+$ | 6.474 |
| $1^+$ | 4.37 | $6^+$ | 6.690 |
| $0.6^+$ | 4.59 | $7^+$ | 6.867 |
| $2.5^+$ | 4.903 | $2.5^+$ | 6.97 |
| $2^+$ | 5.18 | $1.3^+$ | 7.04 |
| $0.7^+$ | 5.35 | $4.0^+$ | 7.201 |
| $6.3^+$ | 5.646 | $3.0^+$ | 7.486 |
| $1.7^+$ | 5.73 | | |

†Photons per 100 n captures

G.A.Bartholomew, B.B.Kinsey, Phys. Rev. 89, 386 (1953).

**Ni** Relative abundances $Ni(CO)_4$; ms

| A | 58 | 60 | 61 | 62 | 64 |
|---|---|---|---|---|---|
| % | 68.0 | 26.3 | 1.13 | 3.66 | 1.01 |

H.C.Mattraw, C.F.Pachucki, AECU-1903(1952); NSA 6, 2526(1952).

Capture $\gamma$'s $Ni(n,\gamma)$ pair s

| | | | |
|---|---|---|---|
| $3^+$ | 5.82 | $9^+$ | 6.84 |
| $0.3^+$ | 5.99 | $0.5^+$ | 7.05 |
| $1.0^+$ | 6.10 | $0.5^+$ | 7.22 |
| $0.8^+$ | 6.34 | $2.8^+$ | 8.12 |
| $2.0^+$ | 6.58 | | |

‡Isotopic assignment uncertain
†Photons per 100 n captures

B.B.Kinsey, G.A.Bartholomew, Phys. Rev. 89, 375 (1953).

**$Ni^{59}$** 28 31

Levels $Ni^{58}(d,p)$ $E_d$ = 10.2 ppl

| | |
|---|---|
| 0.42 | 5.20 |
| 3.08 | 5.66 |
| 4.57 | |

C.E.McFarland, M.M.Bretscher, F.B.Shull, Phys. Rev. 89, 892A(1953).

Capture $\gamma$'s $Ni(n,\gamma)$ pair s

| | | |
|---|---|---|
| $1^+$ | 5.31 | |
| $0.4^+$ | 5.70 | |
| $14^+$ | 8.532 | (also $Ni^{61}$ ?) |
| $35^+$ | 8.997 | |

Assignment from agreement with d,p results; see also Ni
†Photons per 100 n captures in Ni

B.B.Kinsey, G.A.Bartholomew, Phys. Rev. 89, 375 (1953).

**$Ni^{61}$** 28 33

Capture $\gamma$'s $Ni(n,\gamma)$ pair s

| | | |
|---|---|---|
| $4^+$ | 7.528 | |
| $6.5^+$ | 7.817 | |
| $14^+$ | 8.532 | (also $Ni^{59}$ ?) |

Assignment from agreement with d,p results and $Cu^{61}$ decay; see also Ni
†Photons per 100 n captures in Ni

B.B.Kinsey, G.A.Bartholomew, Phys. Rev. 89, 375 (1953).

**$Ni^{63}$** 28 35

F-K plot concave toward energy axis below 30 kev although $S^{35}$ and $Pm^{147}$ plots linear to 10 kev

J.P.Wize, D.C.Zaffarano, Phys. Rev. 91, 210A(1953).

**$Ni^{64}$** 28 36

$\tau_{\beta\beta}$ $> 3 \times 10^{15}$ y ppl

Assuming decay energy $\geq 2$ Mev

J.H.Fremlin, M.C.Walters, Proc. Phys. Soc. 65A, 911(1952).

**Cu** $\gamma$'s Cu(n,n'$\gamma$) $E_n$= 2.7

0.88 scin

~1.5

V.E.Scherrer, W.L.Smith, B.A.Allison, W.R.Faust, Phys. Rev. 91, 768 (1953).

$\gamma$'s Cu(n,n'$\gamma$) $E_n$=14 scin n'$\gamma$

1.1

1.55

2.14

R.E.Garrett, F.L.Hereford, B.W.Sloope, Phys. Rev. 91, 441A (1953); verbal report.

Capture $\gamma$'s Cu(n,$\gamma$) scin

0.150

6.5 - 7

7 - 8

B.Hamermesh, V.Hummel, Phys. Rev. 88, 916(1952).

Capture $\gamma$'s Cu(n,$\gamma$) pair s

| | | | |
|---|---|---|---|
| $0.7^+$ | 5.07 | $0.2^+$ | 5.75 |
| $0.8^+$ | 5.18 | $1^+$ | 6.05 |
| $1^+$ | 5.31 | $1^+$ | 6.41 |
| $1^+$ | 5.43 | $1^+$ | 7.16 |
| $0.5^+$ | 5.64 | | |

‡Isotopic assignment uncertain

†Photons per 100 n captures

G.A.Bartholomew, B.B.Kinsey, Phys. Rev. 89, 386 (1953).

**$Cu^{58}$** 29 29

$\tau$ $3.04^s$ Ni(15-Mev p)

W.W.Martin, S.W.Breckon, Can. J. Phys. 30, 643 (1952).

**$Cu^{61}$** 29 32

$\gamma$ (0.65) $\tau < 2 \times 10^{-9}$ s $\beta\gamma$

T.C.Engelder, Phys. Rev. 90, 259 (1953).

**$Cu^{62}$** 29 33

$\tau$ $9.80^m$

J.Goldenberg, M.D.Sousa-Santos, E.Silva, Ciencid cultura 3, 307(1951); Chem. Abst. 46-10926(1952).

**$Cu^{63}$** 29 34

q -0.16 para

B. Bleaney, K.D.Bowers, R.S.Trenam, Proc. Phys. Soc. 66A, 410 (1953).

**$Cu^{64}$** 29 35

$\beta^+\gamma$? No $\beta^-\gamma$

S.Meric, Istanbul Üniv. Fen Fakült. Mecmuasi 16A, 51(1951).

Capture $\gamma$'s Cu(n,$\gamma$) pair s

| | |
|---|---|
| $3^+$ | 6.69 |
| $2^+$ | 7.01 |
| $5.5^+$ | 7.296 |
| $20^+$ | 7.914 |

Assignment from agreement with d,p results; see also Cu

†Photons per 100 n captures in Cu q, 386

G.A.Bartholomew, B.B.Kinsey, Phys. Rev. 89, 386 (1953).

**$Cu^{65}$** 29 36

q -0.15 para

B. Bleaney, K.D.Bowers, R.S.Trenam, Proc. Phys. Soc. 66A, 410 (1953).

**$Cu^{66}$** 29 37

$\tau$ $5.07^m \pm 0.02$ Cu(pile n)

Counted for 9 half-lives $\beta^-$ electroscope

R.M.Bartholomew, F.Brown, W.D.Howell, W.R.J.Shorey, L.Yaffe, Can. J. Phys. 31, 714 (1953).

$\tau$ $5.10^m$ Cu(slow n)

Counted with $\beta$ electroscope

B.W.Sargent, L.Yaffe, A.P.Gray, Can. J. Phys. 31, 235(1953).

$\gamma$ (1.04) $\tau < 2 \times 10^{-9}$ s $\beta\gamma$

T.C.Engelder, Phys. Rev. 90, 259 (1953).

Capture $\gamma$ Cu(n,$\gamma$) pair s

$9^+$ 7.634 ?

Assignment from agreement with unpublished d,p results, but disagrees with $Zn^{66}$ ($\gamma$,n); see also Cu

†Photons per 100 n captures in Cu

G.A.Bartholomew, B.B.Kinsey, Phys. Rev. 89, 386 (1953).

**$Cu^{67}$** 29 38

$\tau$ $61^h$ Ni(40-Mev $\alpha$)

| | | | | |
|---|---|---|---|---|
| $\beta^-$ | 45% | 0.395 | Zn(195-Mev d) | chem; sl |
| | 35% | 0.484 | | |
| | 20% | 0.577 | | |
| $\gamma$ | | 0.092 | $\alpha$ = 0.5 | E2 |
| | | 0.182 | $\alpha$ = 0.012 | M1 |

H.T.Easterday, Phys. Rev. 91, 653 (1953).

| | | | | |
|---|---|---|---|---|
| $\beta^-$ | | 0.37 | Zn(27-Mev d) | a$\beta\gamma$ |
| | | 0.45 | | a$\beta\gamma$ |
| | ~55% | 0.55 | | a |
| $\gamma$ | st | 0.094 | | scin |
| | st | 0.19 | | |
| | w | 0.30 | | |
| | w | 0.39 | | |

(0.37$\beta$) (0.19$\gamma$) (0.45$\beta$) (0.09$\gamma$)

R.M.Nussbaum, A.H.Wapstra, N.F.Verster, Physica, 19, 131 (1953).

**$Cu^{68}$** 29 39

$\tau$ $32^s$ Zn($\leq$ 15-Mev n) chem; a

$\beta^-$ ~3.0 Ga($\leq$ 15-Mev n)

$\gamma$ weak

A.Flammersfeld, Z.Naturf. 8a, 274 (1953).

**Zn** Capture $\gamma$'s $Zn(n,\gamma)$ scin

1.0
7.5

B.Hamermesh, V.Hummel, Phys. Rev. 88, 916(1952).

Capture $\gamma$'s $Zn(n,\gamma)$ pair s

| | | | |
|---|---|---|---|
| $1.2^+$ | 4.14 | $0.3^+$ | 6.26 |
| $1.6^+$ | 4.84 | $1^+$ | 6.49 |
| $0.7^+$ | 5.23 | $0.5^+$ | 6.65 |
| $2.5^+$ | 5.48 | $2.7^+$ | 6.94 |
| $1^+$ | 5.77 | $2.0^+$ | 7.19 |
| $0.8^+$ | 6.03 | | |

Isotopic assignment uncertain
†Photons per 100 n captures

B.B.Kinsey, G.A.Bartholomew, Phys. Rev. 89, 375 (1953).

$_{30}Zn^{62}_{32}$ $\tau$ $8.4^h$ Ni(13-Mev $He^3$)

D.N.Kundu, T.W.Donaven, M.L.Pool, J.K.Long, Phys. Rev. 89, 1201(1953); Physica 18, 1304 (1952).

$_{30}Zn^{64}_{34}$ $\tau_{\epsilon\epsilon}$ $>3\times10^{15}$ y pc

A.Berthelot, R.Chaminade, C.Levi, L.Papineau, Compt. rend. 236, 1769 (1953).

$_{30}Zn^{65}_{35}$ $\beta^+$ 0.327 sl
$\gamma$ (1.11) $\alpha = 1.8\times10^{-4}$
$\gamma/\beta^+ = 26\pm8$ $Na^{22}$ comparison and ce$^-$/$\beta^+$
No 0.20$\gamma$ (< $3\times10^{-4}$) sl pe$^-$

M.Sakai, P.Hubert, Compt. rend. 236,1249 (1953).

$\beta^+$ (0.327) F-K plot linear to 0.05
$\gamma$ (1.11) $\alpha = 2.6\times10^{-4}$
$\epsilon_K/\beta^+ = 28\pm3$

J.F.Perkins, S.K.Haynes, Phys. Rev. 92, 1096A(1953).

$\gamma$ (1.11) $\alpha = 2.5\times10^{-4}$ sl ce$^-$, Cpt

E.F.Sturcken, A.H.Weber, Phys. Rev. 91,484A (1953).

$\gamma/\beta^+ = 31\pm5$ $Na^{22}$ comparison
No 0.20$\gamma$ (< 0.1%) scin

N.Perrin, J. Phys. radium 14, 273 (1953).

$\epsilon_K/\beta^+ = 33\pm3$ pc

P.Avignon, Compt. rend. 237, 157 (1953).

Capture $\gamma$ $Zn(n,\gamma)$ pair s

| | |
|---|---|
| $10^+$ | 7.876 |

Assignment from agreement with d,p results; see also Zn
†Photons per 100 n captures in Zn

B.B.Kinsey, G.A.Bartholomew, Phys. Rev. 89, 375(1953).

$_{30}Zn^{68}_{38}$ Capture $\gamma$'s $Zn(n,\gamma)$ pair s

| | | | |
|---|---|---|---|
| $0.6^+$ | 8.31 | | |
| $0.2^+$ | 8.58 | | |
| $0.2^+$ | 8.98 | | |
| $1^+$ | 9.12 | | |
| $0.07^+$ | 9.51 | | |

Assigned here since $E_\gamma$ > n binding in other Zn's; see also Zn
†Photons per 100 n captures in Zn

B.B.Kinsey, G.A.Bartholomew, Phys. Rev. 89, 375 (1953)

$_{30}Zn^{69}_{39}$ $13.8^h$ $\gamma$ 0.435 $\alpha = 0.06$ sl ce$^-$, scin

R.B.Duffield, L.M.Langer, Phys. Rev. 89, 854 (1953).

$52^m$ $\beta^-$ 100% 0.897 sl

R.B.Duffield, L.M.Langer, Phys. Rev. 89, 854 (1953).

$_{30}Zn^{70}_{40}$ $\tau_{\beta\beta}$ $>10^{15}$ y
Assuming decay energy ≥2 Mev

J.H.Fremlin, M.C.Walters, Proc. Phys. Soc. 65A, 911(1952).

**Ga** Neutron resonances $E_n$ = 5 ev to 5 kev
94 ev
290 ev

A.W.Merrison, E.R.Wiblin, Proc. Roy. Soc. 215A, 278(1952).

$_{31}Ga^{64}_{33}$ $\tau$ $2.5^m$ $Zn^{64}$(8.1-Mev p)
$\beta+$ ~5 chem scin
$\gamma$ 0.97
2.2?
3.8
$E_{dis}$ = 7.2±0.5 from (p,n) threshold

B.L.Cohen, Phys. Rev. 91, 74 (1953).

$\tau$ $2.6^m$ $Zn^{64}$(9.5-Mev p)
$\beta+$ Zn(19-Mev d) Cu(40-Mev $\alpha$) chem

B.Crasemann, Phys. Rev. 90, 995 (1953).

$_{31}Ga^{65}_{34}$ $\tau$ $15^m$ Cu(21-Mev $He^3$)
$\beta^+$ 2.1

M.L.Pool, Physica 18, 1304(1952).

$\beta^+$ 2.2 Zn(8-Mev d) chem; a

A.H.W.Aten, Jr., H.de Wijs, W.Boelhouwer, Physica 18, 1032(1952).

$\beta+$ 90% 2.1 Zn(19-Mev d) Cu(40-Mev $\alpha$)
10% 2.52 chem; sl

B.Crasemann, Phys. Rev. 90, 995 (1953).

$_{31}Ga^{67}_{36}$ $\gamma$ (0.092) $\tau \sim 1^{\mu s}$
(0.18$\gamma$) (0.30$\gamma$)

S.C.Fultz, R.J.Nash, R.L.Woodward, Phys. Rev. 88, 170A(1952).

$\gamma$ (0.092) $\tau\sim350^{\mu s}$ scin
(0.18$\gamma$) (0.30$\gamma$) Cu(21-Mev $He^3$)

M.L.Pool, Physica 18, 1304(1952).

**$Ga^{67}$** 31 36

$\epsilon$ Zn(p) ion chem
$\gamma$ $\alpha_K$ K/L

| | | | | |
|---|---|---|---|---|
| 2.7% | 0.090 | 0.074 | | M1 |
| 63.9% | 0.092 | 0.83 | 7.0 | E2 |
| 29.6% | 0.182 | 0.011 | 12.6 | M1 |
| 1.0% | 0.206 | 0.029 | ~14 | |
| 20.2% | 0.296 | 0.0029 | 7.8 | M1 |
| 4.9% | 0.388 | 0.0019 | | M1 |
| 0.4% | 0.496 | | | |
| 0.2% | 0.790 | | sl ce⁻ pe⁻, scin | |
| 0.4% | 0.880 | | | |

(0.206$\gamma$) (0.090$\gamma$, 0.182$\gamma$) (all $\gamma$'s) ($\gamma$)
(0.496$\gamma$) (0.296$\gamma$, 0.388$\gamma$)
(0.090$\gamma$, 0.296$\gamma$) (0.092$\gamma$) delay of 8.5$^{\mu s}$
No other delay ($<5\times10^{-7}$ s)
Decay scheme, spins proposed

B.M.Ketelle, A.R.Brosi, F.W.Porter, Phys. Rev. 90, 567 (1953).

**$Ga^{72}$** 31 41

$\gamma$ 64† 2.491 ± 0.002 s$\pi\sqrt{2}$ pe⁻
100† 2.508 ± 0.002

A.Hedgran, D.Lind, Arkiv Fysik 5, 177(1952).

Ge Relative abundances GeF$_4$; ms

| A | 70 | 72 | 73 | 74 | 76 |
|---|---|---|---|---|---|
| | 20.52 | 27.43 | 7.76 | 36.54 | 7.76 |

J.H.Reynolds, Phys. Rev. 90, 1047 (1953).

**$Ge^{71}$** 32 39

$E_{dis}$ 0.23 scin
from continuous $\gamma$ endpoint

B.L.Saraf, J. Varma, C.E.Mandeville, Phys. Rev. 91, 1216 (1953); Phys. Rev. 92, 848A (1953); J.Franklin Inst. 256, 279 (1953).

**$Ge^{75}$** 32 43

$\tau_1$ 48$^s$ $As^{75}(n,p)$ $Ge^{74}(n,\gamma)$
$\gamma$ 0.175 scin

$48^s$

A.B.Smith, R.S.Caird, A.C.G.Mitchell, Phys. Rev. 88, 150(1952).

$82^m$

| | | | |
|---|---|---|---|
| $\beta^-$ | 15% | 0.614 | $Ge^{74}(n,\gamma)$; sl |
| | 85% | 1.137 | |
| $\gamma$ | | 0.265 | sl pe⁻, scin |
| | | 0.408 | sl ce⁻, scin |
| | | 0.572 | sl Cpt, scin |

No (1.137$\beta^-$) ($\gamma$)

A.B.Smith, R.S.Caird, A.C.G.Mitchell, Phys. Rev. 88, 150(1952).

No delayed ce⁻ ($\tau < 1^{\mu s}$)

R.Ballini, Ann. Phys. 8, 441 (1953).

**$Ge^{76}$** 32 44

$\tau_{\beta\beta}$ $>2\times10^{18}$ y ppl
Assuming decay energy $\geq$2 Mev

J.M.Fremlin, M.C.Walters, Proc. Phys. Soc. 65A, 911(1952).

**$Ge^{77}$?** 32 45

$\gamma$ 2.3 Ge(pile n)
2.7
[Due to 14$^h$ $Ge^{72}$ impurity?]

B.L.Saraf, J.Varma, C.E.Mandeville, Phys. Rev. 91, 1216 (1953).

**$Ge^{78}$** 32 46

$\tau$ 86$^m$ $U^{235}$(pile n,f) chem; pc

N. Sugarman, Phys. Rev. 89, 570(1953).

**$As^{70}$** 33 37

| | | | |
|---|---|---|---|
| $\tau$ | 52$^m$ | Ge(28-Mev d) | chem |
| $\beta^+$ | 2.7 | | a |
| $\gamma$ | 1.04* | | scin |
| | 1.7 ?* | | |
| | 2.0* | | |

$K/\beta^+ < 0.2$ $\gamma/\beta^+ \sim 2$

B.Verkerk, A.H.W.Aten, Jr., Physica 18, 974(1952); *A.H.Wapstra, N.F.Verster, ibid.

**$As^{71}$** 33 38

| | | | | |
|---|---|---|---|---|
| $\tau$ | | 60$^h$ | Ge(25-Mev d) | ms |
| $\beta+$ | w | ~0.30? | chem | s |
| | | 0.82 | | |
| $\gamma$ | | 0.0233 | | s ce⁻ |
| | | 0.175 | | |

H.Atterling, S.Thulin, Nature 171, 927 (1953).

| | | | |
|---|---|---|---|
| $\tau$ | 60$^h$ | Ge(14-Mev d) | |
| $\beta+$ | 0.80 | chem | s$\pi\sqrt{2}$ |
| $\gamma$ | 0.175 | K/LM= 8.3 | |

$ce^-_K/\beta+ = 0.14$

P.M.Stoker, O.P.Mok, Physica 19, 279 (1953).

**$As^{72}$** 33 39

$\gamma$ 0.697 Ge(14-Mev d)
$ce^-_K/\beta+ = 0.0090$ chem s$\pi\sqrt{2}$ ce⁻

P.M.Stoker, O.P.Mok, Physica 19, 279 (1953).

**$As^{73}$** 33 40

$\gamma$ 0.0130 Ge(14-Mev d)
0.053 K/LM=5.2 chem; ce⁻

P.M.Stoker, O.P.Mok, Physica 19, 279 (1953).

$\gamma$ 0.0135 $\alpha$= large $\tau = 4.8^{\mu s}$
0.054 $900^{\mu s} < \tau < 10^s$
0.0135 $\gamma$ follows 0.054 $\gamma$ scin

J.P.Welker, A.W.Schardt, J.J.Howland, Jr., G.Friedlander, Phys. Rev. 91, 484A (1953).

**$As^{75}$** 33 42

$\mu$ 1.43524 I
$\nu(As^{75})/\nu(D) = 1.11569 \pm 0.00005$
$Na_2HAsO_4$, $D_2O$

Y.Ting, D.Williams, Phys. Rev. 89, 595(1953).

No isomeric state observed after 5 min.
Separation of As from $Se^{75}$

E.N.Jensen, L.J.Laslett, D.S.Martin, Jr., E.J. Hughes, W.W.Pratt, Phys. Rev. 90, 557 (1953).

**$As^{76}$** 33 43

| | | | |
|---|---|---|---|
| $\beta^-$ | 3% | 0.48 | As(pile n); s$\pi\sqrt{2}$ |
| | 12% | 1.76 | |
| | 33% | 2.40 | |
| | 52% | 2.98 | $\Delta I = 2$, yes shape |
| $\gamma$ | | 0.558 | $\alpha_K = 0.002$ ce⁻ |

E.P.Tomlinson, S.L.Ridgway, Phys. Rev. 88, 170A(1952), verbal report.

**$As^{76}$** 33 43

| | | | | |
|---|---|---|---|---|
| $\gamma$ | 0.56 | (E)2 | | $\gamma\gamma(\theta)$ |
| | 0.65 | (E)2 | (>85%) | $\gamma\gamma(\theta)$ |
| (0.65$\gamma$) (0.56$\gamma$) ($\theta$) | | I = 2, 2, 0 | | scin |

F.R.Metzger, W.B.Todd, J.Franklin Inst. 256, 277 (1953).

| | | | | |
|---|---|---|---|---|
| $\gamma$ | 0.56 | (E)2 | | $\gamma\gamma(\theta)$ |
| | 0.65 | (M)1 | (20-66%) | $\gamma\gamma(\theta)$ |
| | 1.21 | | | |
| | 2.1 | | | |
| (0.65$\gamma$) (0.56$\gamma$) ($\theta$) | I = 2,2,0 | As(slow n) | | scin |

J.J.Kraushaar, M.Goldhaber, Phys. Rev. 89, 1081 (1953).

(~2$\beta$) (~0.6$\gamma$) ($\theta$) b = 0.076 sl

H.Rose, Phil. Mag. 44, 739 (1953).

**$As^{77}$** 33 44

| | | | |
|---|---|---|---|
| $\tau$ | 38.0$^h$ | $U^{235}$(pile n,f) | chem; pc |

N.Sugarman, Phys. Rev. 89, 570(1953).

| | | | | | |
|---|---|---|---|---|---|
| $\tau$ | 38.7$^h$ | U(n,f) | Ge(n,$\gamma\beta$) | | chem |
| $\gamma$ 14† | 0.023 | | | | scin |
| | 0.028 | | | | |
| 20† | 0.086 | | | | |
| 10† | 0.160 | | | | |
| 150† | 0.246 | | | | |
| 50† | 0.524 | | | | |

†Photons per $10^4$ disintegrations

M.E.Bunker, R.J.Prestwood, J.W.Starner, Phys. Rev. 91, 1021 (1953).

| | | | |
|---|---|---|---|
| $\tau$ | 39$^h$ | Ge(pile n,$\gamma\beta$) | chem |
| $\gamma$ | 0.033? | | scin |
| 140† | 0.25 | | |
| 50† | 0.53 | | |
| (~0.44$\beta$) (0.25$\gamma$) | | | $\alpha\beta\gamma$ |

†Photons per $10^4$ disintegrations

S.A.Reynolds, G.W.Leddicotte, H.A.Mahlman, Phys. Rev. 91, 333 (1953).

| | | | |
|---|---|---|---|
| $\gamma$ | 0.032 | d $12^h$Ge | scin |
| 25† | 0.087 | | |
| 8† | 0.160 | | |
| 165† | 0.247 | | |
| 3† | 0.270 | | |
| 50† | 0.520 | | |

(0.27$\gamma$) (0.25$\gamma$) No(0.52$\gamma$) ($\gamma$)
(~0.44$\beta$) (0.25$\gamma$) No(0.66$\beta$) ($\gamma$)

†Photons per $10^4$ disintegrations

B.L.Saraf, J.Varma, C.E.Mandeville, Phys. Rev. 91, 1216 (1953); Phys. Rev. 92, 848A (1953); J. Franklin Inst. 256, 279 (1953).

| | | | |
|---|---|---|---|
| $\gamma$ 30† | 0.088 | d $12^h$Ge | |
| ~20† | 0.155 | | scin |
| 230† | 0.243 | | |
| 70† | 0.528 | | |

(0.155$\gamma$) (0.088$\gamma$)
No(0.52$\gamma$) ($\gamma$) No(0.24$\gamma$) (0.088$\gamma$,0.155$\gamma$)

†Photons per $10^4$ disintegrations

F.Rasetti, E.C.Booth, Phys. Rev. 91, 1192(1953).

**$As^{78}$** 33 45

| | | | | |
|---|---|---|---|---|
| $\tau$ | 91.0$^m$ | d 86$^m$Ge$^{78}$ | $U^{235}$(pile n,f$\beta^-$) | |
| No ~40$^m$ activity observed | | | | chem; pc |

N.Sugarman, Phys. Rev. 89, 570(1953).

| | | | |
|---|---|---|---|
| $\tau$ | 88$^m$ | U(n,f) | chem |
| $\beta^-$ | 4.1 | | $\alpha$ |

No 40$^m$ As activity found but did find Sb(?) with $\tau$~ 30$^m$

J.G.Cuninghame, Phil. Mag. 44, 900 (1953).

**$As^{79}$** 33 46

| | | | |
|---|---|---|---|
| $\tau$ | 9.0$^m$ | U(n,f) | chem |
| $\beta^-$ | 2.3 | p 3.9$^m$Se | $\alpha$ |

J.G.Cuninghame, Phil. Mag. 44, 900 (1953).

**$Se^{75}$** 34 41

| | | | | |
|---|---|---|---|---|
| $\epsilon$ (no $\beta^+$s) | | | Se(pile n) | |
| $\gamma$ 0.5% | 0.067 | | | sl ce$^-$ pe$^-$ |
| 14% | 0.077 | | | |
| 6.5% | 0.098 | $\alpha_K$~8 | K/L=11 | |
| ~3% | 0.124 | $\alpha_K$~0.3 | | |
| 24% | 0.138 | $\alpha_K$=0.12 | | |
| 0.04% | 0.203 | | | |
| 71% | 0.269 | $\alpha_K$=0.09 | | |
| ~5% | 0.281 | | | |
| 0.03% | 0.308 | | | |
| 14% | 0.405 | $\alpha_K$=0.0015 | | |
| No 0.0247 $\gamma$ | | No delayed $\gamma\gamma$(0.3$^{\mu s}$-10$^{\mu s}$) | | |
| (<0.15$\gamma$) ($\gamma$) | | Decay scheme proposed | | |

E.N. Jensen, L.J.Laslett, D.S.Martin, Jr., F.J. Hughes, W.W.Pratt, Phys. Rev. 90, 557 (1953).

**$Se^{77}$** 34 43 $17^s$

| | | |
|---|---|---|
| $\gamma$ | 0.16 | Se(fast n); sl ce$^-$ |

J.Orring, Arkiv Fysik 4, 469(1952).

| | | |
|---|---|---|
| $\gamma$ | 0.13 | Se(pile n); pc, scin |

J.H.Kahn, ORNL - 1089(1951).

| | | | |
|---|---|---|---|
| stable | $\mu$ | 0.53262 | $H_2Se$ Mic |
| | $\nu(Se^{77})/\nu(D)$=1.24211±0.00010 | | |

H.E.Walchli, Phys. Rev. 90, 331 (1953).

**$Se^{79}$** 34 45 $3.9^m$

| | | | |
|---|---|---|---|
| $\tau_1$ | 3.88$^m$ | d 9$^m$As | chem |

J.G.Cuninghame, Phil. Mag. 44, 900 (1953).

**$Se^{82}$** 34 48

| | | |
|---|---|---|
| $\tau$ | >$10^{17}$y | Se chem |
| No 36$^h$ Br detected | | |

H.D.Sharma, Curr. Sci. 22, 45 (1953).

**$Br^{77}$** 35 42

| | | | |
|---|---|---|---|
| $\gamma$ | 0.023? | 0.524 | scin |
| | 0.086 | 0.58 | |
| | 0.160 | 0.76 | |
| | 0.246 | 0.82 | |
| | 0.300 | 1.00 | |

No 0.641$\gamma$

M.E.Bunker, R.J.Prestwood, J.W.Starner, Phys. Rev. 91,1021 (1953).

**$Br^{78}$** 35 43 6.3$^m$

| | |
|---|---|
| Br $K_\alpha$ x rays | cryst |
| Suggest known 0.046 and 0.108 $\gamma$'s are from isomeric state in $Br^{78}$ | |

P.Marmier, P.Preiswerk, quoted by P.Stähelin, P.Preiswerk, Nuovo Cim. 10, 1219 (1953).

**$Br^{79}$** 35 44

$\mu(Br^{81})/\mu(Br^{79}) = 1.07794$ M

Q 0.335

$Q(Br^{79})/Q(Br^{81}) = 1.19707$

J.G.King, V.Jaccarino, Phys. Rev. 91, 209A(1953).

$Q(Br^{79})/Q(Br^{81}) = 1.1967$ quad res

E.Manring, C.Brown, D.Williams, Phys. Rev. 90,348A (1953).

$Q(Br^{79})/Q(Br^{81}) = 1.1970$ $C_2H_5Br$ quad res

S.Kojima, K.Tsukada, S.Ogawa, A.Shimauchi, J. Chem. Phys. 21, 1415 (1953).

**$Br^{80}$** 35 45 18m

No $\gamma$ ($\gamma/\beta^+ \leqslant 1.25$)

J.Laberrique-Frolow, R. Bernas, H.Langevin, Compt. rend. 236, 1246 (1953).

$\gamma$ 0.62 Br(pile n) scin

$\gamma/\beta^- = 0.09$ $(\beta)(0.62\gamma)$

No$(0.511\gamma)(0.62\gamma)$ No$(x)(0.62\gamma)$

G.S.Goldhaber, M.McKeown, Phys. Rev. 92, 356(1953).

**$Br^{81}$** 35 46

$\mu(Br^{81})/\mu(Br^{79}) = 1.07794$ M

Q 0.280

$Q(Br^{79})/Q(Br^{81}) = 1.19707$

J.G.King, V.Jaccarino, Phys, Rev. 91,209A(1953).

**$Br^{82}$** 35 47

| | | | |
|---|---|---|---|
| $\gamma$ | 38†† | 0.535 | s |
| | | 0.602 | |
| | 353† | 0.750 | |
| | 100† | 1.02 | |
| | 85† | 1.29 | |
| | 40† | 1.45 | |

B.Dzhelepov, A.Siiant'ev, Doklady Akad. Nauk SSSR. 85, 533(1952); NSA 6-6197(1952).

$\beta e^-$ delay < several $\mu s$

R.Ballini, Ann. Phys. 8, 441 (1953).

**$Br^{84}$** 35 49

| | | | |
|---|---|---|---|
| $\gamma$ | st | 0.890 | scin |
| | w | 1.89 | |

L.W.Langer, R.B.Duffield, Quoted by C.W.Huddleston, A.C.G.Mitchell, Phys. Rev. 88, 1350(1952).

**$Br^{87}$** 35 52

| | | | | |
|---|---|---|---|---|
| $\beta^-$ | 70% | 2.6 | U(n,f) | a$\beta\gamma$ |
| | 30% | 8.0 | chem | a |
| $\gamma$ | 80† | 2-4 | | |
| | 20† | 5.4 | | |

n emission (2%), presumably following 2.6$\beta$

$(2.6\beta)(\gamma)$ $\gamma\gamma$

A.F.Stehney, N.Sugarman, Phys. Rev. 89,194(1953).

**$Kr^{83}$** 36 47

$\tau$ $1.86^h$

L.J.de Vries, F.T.H.Veringa, J.Clay, Koninkl. Ned. Akad. Wetenschap., Proc. 55B, 303(1952).

**$Kr^{85}$** 36 49 4 4h

| | | | | |
|---|---|---|---|---|
| $\beta^-$ | 85% | 0.83 | Kr(n,$\gamma$) U(n,f) | ms; sl |
| $\gamma$ | 85% | 0.1495 | $\alpha_K = 0.041$ | M1 ce$^-$ |
| $\gamma$ IT | 15% | 0.3050 | K/LM = 7 | |

[$\beta$] [$e^-_K(0.15\gamma)$]

I.Bergström, Arkiv Fysik 5, 191(1952).

**$Kr^{85}$** 36 49 10y

$\tau_2$ $10.27^y$ U(n,f) chem ms

From decrease in abundance in seven years

R.K.Wanless, H.G.Thode, Can. J. Phys. 31,517 (1953).

$\beta^-$ 0.666 $\Delta I = 2$, yes shape sl

Kr(n,$\gamma$) U(n,f) ms

I.Bergström, Arkiv Fysik 5, 191(1952).

**$Kr^{88}$** 36 52

| | | | | |
|---|---|---|---|---|
| $\beta^-$ | 68% | 0.52 | U(n,f) | ms; sl |
| | 12% | 0.9 ? | | |
| | 20% | 2.7 | | a$\beta\gamma$; sl |
| $\gamma$ | | 0.028 | K/LM = 8 | |

[$e^-_K(0.028\gamma)$] [~0.5$\beta$]; $e^-/\beta = 0.085$

S.Thulin, Arkiv Fysik 4, 363(1952).

**$Rb^{82}$** 37 45 6.3h

| | | | | | |
|---|---|---|---|---|---|
| $\beta^+$ | 24† | 0.175 | Br(<20-Mev $\alpha$); | | sl |
| | 76† | 0.775 | | | |
| $\gamma$ | | 0.188 | 0.464 | 0.818 | ce$^-$, pe$^-$ |
| | | 0.248 | 0.550 | 1.020 | |
| | | 0.322 | 0.610 | 1.314 | |
| | | 0.389 | 0.690 | 1.464 | |
| | | 0.423 | 0.768 | v st | |

C.W.Huddleston, A.C.G.Mitchell, Phys. Rev. 88, 1350(1952).

**$Rb^{82}$ ?** 37 45

$\tau$ $76^s$ d $25.5^d$Sr a

$\beta^+$ 4.2

$\beta^+$ observed in $25.5^d$Sr but assigned here

P.Kruger, N.Sugarman, Phys. Rev. 90, 158(1953).

**$Rb^{84}$** 37 47 23m

| | | | | |
|---|---|---|---|---|
| $\tau_1$ | | $21^m$ | Rb(fast n) | ion chem |
| $\gamma$ | $25^+$ | 0.239 | | scin |
| | $10^+$ | 0.463 | | |

$(0.23\gamma)(0.23\gamma)$ No $(0.23\gamma)(0.46\gamma)$ scin

No x rays observed pc

R.S.Caird, A.C.G.Mitchell, Phys. Rev. 89, 573 (1953).

40d

| | | | | |
|---|---|---|---|---|
| $\beta^+$ | ~3† | 0.37 ? | Br(<20-Mev $\alpha$); | s$\pi$, sl |
| | 58† | 0.82 | | |
| | 39† | 1.629 | $\Delta I = 2$, yes shape | |
| $\gamma$ | | 0.890 | scin, s$\pi$ | ce$^-$ |

No other $\gamma$ No $\beta^-$ (vw if present)

(~0.8$\beta^+$)($\gamma$) No (1.6$\beta^+$)($\gamma$)

C.W.Huddleston, A.C.G.Mitchell, Phys. Rev. 88, 1350(1952).

**$Rb^{86}$** 37 49 1.0m

| | | |
|---|---|---|
| $\tau_1$ | $1.02^m$ | $Rb^{85}$(pile n) |
| $\gamma$ | 0.56 | scin |

No x rays (< 3%) consistent with E3, E4 pc

R.B.Schwartz, M.L.Perlman, W.Bernstein, Phys. Rev. 91, 883 (1953).

19d $\epsilon_k$ <0.1% Rb(pile n) chem; pc

R.B.Schwartz, M.L.Perlman, W.Bernstein, Phys. Rev. 91, 883 (1953).

$\beta\gamma$ polarization - direction

1.08$\gamma$ no parity change

D.R.Hamilton, A.Lemonick, F.W.Pipkin, Phys. Rev. 90,370A(1953); verbal report.

**$Rb^{87}$** 37 50

$\tau$ $5.90 \times 10^{10}$ y RbI(Tl) scin
$\beta^-$ 0.275 F-K plot not linear
No $ce^-$ or $\gamma$

G.M.Lewis. Phil. Mag. 43, 1070(1952).

$\tau$ $\geq 4.8 \times 10^{10}$ y
No $(\beta)(e^-)$ $4\pi$ counter

I.Bähnisch, E.Huster, W.Walcher, Naturwiss. 39, 379(1952).

**$Rb^{88}$** 37 51

$\tau$ 17.7 m d $2.7^h$Kr; sl
$\beta^-$ 13% 2.5 $\Delta I = 2$, yes shape
9% 3.6
78% 5.3

S.Thulin, Arkiv Fysik 4, 363(1952).

**$Sr^{82}$ ?** 38 44

$\tau$ 25.5 d Ag(450-Mev p) chem
Parent $76^s$Rb; not p $6.3^h$Rb (< 1%) chem

P.Kruger, N.Sugarman, Phys. Rev. 90, 158(1953).

**$Sr^{87}$** 38 49
$2.7^h$

$\tau_1$ 2.88 h Sr(d) d $80^h$Y chem
$\gamma$ 0.3882 K/LM = 5.8 s

G.A.Graves, L.M.Langer, R.D.Moffat, Phys. Rev. 88, 169A and 344(1952).

stable $\mu$ -1.0895 $SrBr_2$ I
$\nu(Sr^{86})/\nu(D) = 0.28322 \pm 0.00003$ 60% $Sr^{87}$

C.D.Jeffries, P.B.Sogo, Phys. Rev. 91,1286(1953).

**$Sr^{88}$** 38 50

$\tau_{\beta\beta}$ $> 3 \times 10^{18}$ y ppl
Assuming decay energy $\geq 2$ Mev

J.H.Fremlin, M.C.Walters, Proc. Phys. Soc. 65A, 911(1952).

**$Sr^{89}$** 38 51

Levels Sr(d,p) $E_d$ = 10.4 s
1.07
2.07
2.54

C.E.McFarland, F.B.Shull, Phys. Rev. 89, 489(1953).

Levels Sr(d,p) $E_d$ = 8.01 ppl
1.07 4.73
2.09 5.46
2.66

J.R.Holt, T.N.Marsham, Proc. Phys. Soc. 66A,565 (1953).

$\tau$ 9.67 h U(n,f) chem sl
$\beta^-$ 7% 0.61
33% 1.09
29% 1.36
4% 2.03
27% 2.67 $\Delta I$=2, yes shape
$\gamma$ 20.6† 0.552 sm pe⁻ scin
5.2† 0.645
9.2† 0.748
1.1† 0.93
10.4† 1.025
1.8† 1.413
$(\gamma)(0.65\gamma)$ $(\gamma)(0.83\gamma)$ $(\gamma)(1.41\gamma)$

D.RAmes, M.E.Bunker, L.M.Langer, B.M.Sorenson, Phys. Rev. 89, 903A; 91,68 (1953).

**$Y^{82}$** 39 43

$\tau$ ~70 m Y(130-Mev p) p $26^d$Sr chem

A.A.Caretto, Jr., E.O.Wiig, J. Am. Chem. Soc. 74, 5235(1952).

**$Y^{83}$** 39 44

$\tau$ 3.5 h Y(130-Mev p) p $38^h$Sr chem

A.A.Caretto, Jr., E.O.Wiig, J. Am. Chem. Soc. 74, 5235(1952).

**$Y^{85}$** 39 46

$\tau$ 5 h Y(130-Mev p) p $65^d$Sr chem

A.A.Caretto, Jr., E.O.Wiig, J. Am. Chem. Soc. 74, 5235(1952).

**$Y^{87}$** 39 48
$14^h$

$\gamma$ 0.3813 K/LM = 5.4 s
No $ce^-$ in region above 1 Mev

G.A.Graves, L.M.Langer, R.D.Moffat, Phys. Rev. 88, 169A and 344(1952).

$80^h$ $\gamma$ 0.4834 K/LM~7 s

G.A.Graves, L.M.Langer, R.D.Moffat, Phys. Rev. 88, 169A and 344(1952).

**$Y^{88}$** 39 49

$\gamma$ (0.91) $\alpha_K = 3.4 \times 10^{-4}$ E1
(1.85) $\alpha_K = 1.7 \times 10^{-4}$ E2,M1

F.R.Metzger, M.C.Amacher, Phys. Rev. 88, 147 (1952).

$(0.908\gamma)(1.85\gamma)(\theta)$ I=3,2,0
$\gamma$ (0.908) (E)1 (M)2<0.001%

J.Varma, B.L.Saraf, W.B.Todd, Jr., Phys. Rev. 91, 484A (1953).

$(0.908\gamma)(1.85\gamma)(\theta)$ I=3,2,0
$\gamma$ (0.908) (E)1 (M)2 0.002-0.015%

R.M.Steffen, Phys. Rev. 90, 321 (1953).

**$Y^{90}$** 39 51

$\gamma$ 0.05% ~1.5
From deviation from theoretical shape of inner bremsstrahlung absorbed in Pb

B.Maklej, Acta Phys. Polon. 12, 32(1953).

**$Y^{91}$** 39 52
$51^m$

$\tau_1$ 50.3 m d 9.7 h Sr chem
$\gamma$ 0.551 $\alpha_K$=0.046 sm $ce^-$
K/LM=8.0 M4

No $\beta^-$ (< 1.5% of IT)

D.P.Ames, M.E.Bunker, L.M.Langer, B.M.Sorenson, Phys. Rev. 89, 903A; 91 68 (1953).

$\gamma$ 0.5512 K/LM = 6.0 s

G.A.Graves, L.M.Langer, R.D.Moffat, Phys. Rev. 88, 169A and 344(1952).

$57^d$ $\tau_2$ 61 d
$\beta^-$ 1.54 $\Delta I = 2$, yes shape scin
1.18$\gamma$ observed with $\tau \sim 160^d$ No(1.18$\gamma$)($\beta$)

F.I.Boley, D.S.Dunavan, Phys. Rev. 90, 158(1953).

Continuous $\gamma$ spectrum scin
$\gamma(E_\gamma > 0.09)/\beta^- = 0.0019$

P.Boigiano, L.Madansky, F.Rasetti, Phys. Rev. 89, 679(1953).

**$Y^{92}$** (39 53)

Mass assignment of 3.5$^h$ activity confirmed from Zr(7.8-Mev d,$\alpha$) yields

G.L.Schott, W.W.Meinke, Phys. Rev. 89, 1156(1953).

**$Y^{94}$** (39 55)

Mass assignment of 16.5$^m$ activity confirmed from Zr(7.8-Mev d,$\alpha$) yields

G.L.Schott, W.W.Meinke, Phys. Rev. 89, 1156(1953).

**$Zr^{89}$** (40 49) 4.5$^m$

| | | | | |
|---|---|---|---|---|
| $\tau_1$ | | 4.25$^m$ | | Zr($\leq$24-Mev $\gamma$) |

L.Katz, R.G.Baker, R.Montalbetti, Can. J. Phys. 31, 250(1953).

| | | | | |
|---|---|---|---|---|
| $\tau_1$ | | 4.40$^m$ | | $Zr^{90}$ ($\ll$22-Mev $\gamma$) |
| $\beta^+$ | 1.5% | ~0.85 | | $a\beta\gamma$ |
| | ~0.4% | 2.43 | | scin |
| $\gamma$ | 100† | 0.588 | K/LM = 5.4 | $\alpha$ = 0.08 |
| | 8† | 1.53 | | |

(0.85$\beta^+$) (1.53$\gamma$)

$\beta^+/0.59\gamma$ = 0.019

F.J.Shore, W.L.Bendel, H.N.Brown, R.A.Becker, Phys. Rev. 91, 1203 (1953).

80$^h$

| | | | | |
|---|---|---|---|---|
| $\tau_2$ | | 78$^h$ | | Zr($\leq$24-Mev $\gamma$) |

L.Katz, R.G.Baker, R.Montalbetti, Can. J. Phys. 31, 250(1953).

| | | | | |
|---|---|---|---|---|
| $\tau_2$ | | 79$^h$ | | $Zr^{90}$ ($\ll$22-Mev $\gamma$) |
| $\beta^+$ | | 0.90 | | sm |
| $\gamma$ | | 0.913 | K/LM = 7 | ce$^-$ |

No $\gamma$ ($E_\gamma$ = 0.95-2.0) < 1%

$\beta^+/0.91\gamma$ = 0.2

F.J.Shore, W.L.Bendel, H.N.Brown, R.A.Becker, Phys. Rev. 91, 1203 (1953).

**$Zr^{95}$** (40 55)

| | | | | |
|---|---|---|---|---|
| $\tau$ | | 65$^d$ | | $Zr^{94}$(pile n,$\gamma$) U(pile n,f) |
| $\beta^-$ | ~49% | ~0.360 | | sm N 2 |
| | ~49% | ~0.400 | | |
| | ~ 2% | 0.910 | | |
| $\gamma$ | | 0.235 | K/L = 4.5 | sm ce$^-$ |
| | | 0.725 | K/L = 5 | |
| | | 0.758 | | |

J.M.Cork, J.M.LeBlanc, D.W.Martin, W.H.Nestor, M.K.Brice, Phys. Rev. 90, 579 (1953).

| | | | | |
|---|---|---|---|---|
| $\beta^-$ | 98% | 0.370 | | Zr(pile n) ion chem |
| | 1% | 0.84 | | s |
| $\gamma$ | | 0.721 | $\alpha$ = 0.0024 | s pe$^-$, ce$^-$ |

No 0.92$\gamma$

H.Slätis, L.Zappa, Arkiv Fysik 6, 81(1953).

| | | | | |
|---|---|---|---|---|
| $\beta^-$ | 54% | 0.364 | | s |
| | 43% | 0.396 | | |
| $\gamma$ | | 0.722 | $\alpha_K$ = 0.0014 | s ce$^-$ |
| | | 0.754 | $\alpha_K$ = 0.0011 | |

$\beta\gamma$ ($\theta$) b = 0.00 ± 0.03

P.S.Mitteiman, Phys. Rev. 91,484A(1953); verbal report.

| | | | |
|---|---|---|---|
| $\gamma$ | 0.73 | U(n,f) | chem; scin |

($\beta$) (0.73$\gamma$) indicates $\gamma/\beta \sim 1$

C.E.Mandeville, E.Shapiro, R.I.Mendenhall, E.R. Zucker, G.L.Conklin, Phys. Rev. 89, 559(1953).

**$Zr^{96}$** (40 56)

| | | | |
|---|---|---|---|
| $\tau_{1/2}$ | 6x10$^{16}$y | 89.5% $Zr^{96}$ | scin |
| $\beta$ or $\gamma$ of 3.8±0.5 | | | |

J.A.McCarthy, Phys. Rev. 90, 853 (1953).

**$Nb^{90}$** (41 49)

| | | | |
|---|---|---|---|
| $\tau$ | 14.7$^h$ | d 5.7$^h$Mo | chem |
| $\beta^+$ | 1.2 | Al | a |

Absorption due to x rays, $\beta^+$ or both

R.M.Diamond, Phys. Rev. 89, 1149(1953).

**$Nb^{92}$** (41 51)

No $\beta^-$ (< 0.05%)

| | | | |
|---|---|---|---|
| $\gamma$ | 0.930 | $\alpha$ = 8x10$^{-4}$ | s |

P.Stähelin, P.Preiswerk, Nuovo Cim. 10, 1219(1953). Helv. Phys. Acta 24, 300 (1951).

| | | | | |
|---|---|---|---|---|
| No $\beta^-$ | | | $Nb^{93}$(20-Mev p) | chem; a,s |
| $\gamma$ | ~100† | 0.933 | | scin |
| | 1† | 1.84 | | |

H.K.Ticho, D.Green, J.R.Richardson, Phys. Rev. 86, 422(1952); 87, 195A(1952); priv. comm.

**$Nb^{94}$** (41 53) 6.6$^m$

| | | | |
|---|---|---|---|
| $\gamma$ | (0.042) | $\alpha_K$>100 | Nb(pile n); pc |

J.H.Kahn, ORNL-1089(1951).

long

| | | | | |
|---|---|---|---|---|
| $\tau_2$ | | 2.2x10$^{4}$y* | Nb(pile n) | chem |
| $\beta^-$ | | 0.50 | | a |
| $\gamma$ | 92† | 0.70 | | scin |
| | 92† | 0.87 | | |
| | 8† | 1.57 | | |

*Based on $\sigma_d(Nb^{93})$ = 1.1

D.L.Douglas, A.C.Newherter, R.P.Schuman, Phys. Rev. 92, 369 (1953).

**$Nb^{95}$** (41 54) 90$^h$

| | | | | |
|---|---|---|---|---|
| $\tau_1$ | | 84$^h$ | d 65$^d$Zr | chem |
| $\gamma^1$ | | 0.231 | | s ce$^-$ |

H.Slätis, L.Zappa, Arkiv Fysik 6, 81(1953).

| | | | |
|---|---|---|---|
| $\gamma$ | 0.235 | K/L = 4.5 | sm ce$^-$ |

J.M.Cork, J.M.LeBlanc, D.W.Martin, W.H.Nestor M.K.Brice, Phys. Rev. 90, 579 (1953).

| | | | |
|---|---|---|---|
| $\gamma$ | (0.22) | K/LM = 2.5 | sl ce$^-$ |

V.S.Shpinel, Zhur. Ekspti' i Teoret. Fiz. 22, 255(1952); Phys. Abst. 55-8254(1952).

35$^d$

| | | | | |
|---|---|---|---|---|
| $\tau_2$ | | 35.0$^d$ | d 65$^d$Zr; | chem |
| $\beta^-$ | | 0.165 | | sm N2 |
| $\gamma$ | | 0.753 | | sm ce$^-$ |
| | | 0.768 | K/L = 7.6 | |

Evidence for low energy $\gamma$ a

J.M.Cork, J.M.LeBlanc, D.W.Martin, W.H.Nestor, M.K.Brice, Phys. Rev. 90, 579 (1953).

| | | | |
|---|---|---|---|
| $\beta^-$ | 0.159 | d 65$^d$Zr | chem |
| $\gamma$ | 0.745 | $\alpha$ = 0.0024 | s; ce$^-$ |

H.Slätis, L.Zappa, Arkiv Fysik 6, 81(1953).

| | | | | |
|---|---|---|---|---|
| $\beta^-$ | | 0.171 | | sl |
| $\gamma$ | | 0.771 | $\alpha$ = 0.0018 | K/LM = 2.4 |

E.F.Strucken, A.H.Weber, Phys. Rev. 91,484A (1953); verbal report.

**$Nb^{95}$** (41 54, $35^d$)

$\gamma$ **0.774** K/LM = 6.6 s ce$^-$

R.E.Maerker, R.D.Birkhoff, Phys. Rev. 89, 1159 (1953).

$\gamma$ **0.76** d $65^d Zr$ chem; scin

($\beta$)(0.76$\gamma$) indicates $\gamma/\beta \sim 1$

C.E.Wandeville, E.Shapiro, R.I.Wendenhall, E.R. Zucker, G.L.Conklin, Phys. Rev. 89, 559(1953).

$\gamma$ **0.764** s ce$^-$

P.S.Mittelman, Phys. Rev. 91,484A(1953).

**$Nb^{97}$** (41 56)

$\gamma$ (0.665) $\tau > 1.5\times10^{-12}$s

From attempt to detect nuclear resonance scattering from $Mo^{97}$

F.R.Metzger, W.B.Todd, Phys. Rev. 91, 1286(1953).

**Mo**

Neutron resonances (ev) $E_n$ = 1 ev to 10 kev

**46.3** $\sigma_o\Gamma^2 = 400$

**75**

**140**

**~440**

E.R.Hodgson, J.F.Gallagher, E.M.Bowey, Proc. Phys. Soc. 65A, 992(1952).

**$Mo^{90}$** (42 48)

$\tau$ **$5.7^h$** $Nb^{93}$(55-Mev p) chem

$\beta^+$ **~1.4 ?*** Al a

$\gamma$ **~0.12** Pb a

**~0.25**

**1.1**

*Absorption due to x rays, $\beta^+$ or both

R.M.Diamond, Phys. Rev. 89, 1149(1953).

**$Mo^{91}$** (42 49, $75^s$)

$\tau_1$ **$65.5^s$** Mo($\leq$ 24-Mev $\gamma$)

$\sigma(65.5^s)/\sigma(15.5^m) = 0.2$ for $E_\gamma$ = 16-20 indicating $65.5^s$ state has larger spin

L.Katz, R.G.Baker, R.Montalbetti, Can. J. Phys. 31, 250(1953).

No $65.5^s$ activity from Mo (14.4-Mev n,2n); weak activity from Mo (18-Mev n,2n)

J.E.Brolley, Jr., Phys. Rev. 89, 877(1953); 88, 618(1952).

($16^m$)

$\tau_2$ **$15.5^m$** Mo($\leq$ 24-Mev $\gamma$)

$\beta^+$ **3.3** a

$65.5^s$ level 0.15 ± 0.05 Mev above $15.5^m$ g.s. from Mo($\gamma$,n) thresholds

L.Katz, R.G.Baker, R.Montalbetti, Can. J. Phys. 31, 250(1953).

**$Mo^{93}$** (42 51, $6.7^h$)

$\tau_1$ **$6.95^h$** Nb(p,n) chem, rel $\sigma$

$\gamma$ ~ 80$^+$ **0.290** scin

~100$^+$ **0.690**

~100$^+$ **1.464**

G.E.Boyd, R.A.Charple, Phys. Rev. 88, 681(1952).

**$Mo^{93}$** (42 51, $6.7^h$)

| $\gamma$ | | $\alpha_K$* | K/L | sπ ce$^-$ |
|---|---|---|---|---|
| | **0.262** | 0.53 | 3.09 | E4 |
| | **0.684** | $1.5\times10^{-3}$ | 8 | M1 |
| | **1.479** | $2.4\times10^{-4}$ | | E2,M1 |

Mo x rays crit a, cryst

*Based on $\alpha$ (0.262$\gamma$) = 0.7

C.W.Forsthoff, R.H.Goeckermann, R.A. Naumann, Phys. Rev. 90, 1004 (1953).

Mass assignment of $6.7^h$ activity confirmed with ms Nb(6.7-Mev d) chem

$\gamma$ **0.27** scin

**0.70**

**1.5**

R.Bernas, J.Beydon, Compt. rend. 236, 194(1953).

Mass assignment of $6.7^h$ activity confirmed with ms Nb(25-Mev d)

$\gamma$ **0.264** K/LM=2.8 L/M~3 sπ√2 ce$^-$

**0.685** pe$^-$

**1.479** pe$^-$

D.E.Alburger, S.Thulin, Phys. Rev. 89, 1146(1953).

**$Mo^{100}$** (42 58)

$\tau_{\beta\beta}$ $\geq 10^{15}$y ppl

Assuming decay energy $\geq$2 Mev

Definite evidence of activity

J.H.Fremlin, M.C.Walters, Proc. Phys. Soc. 65A, 911(1952).

**$Tc^{93}$** (43 50, $44^m$)

$\tau_1$ **$43.5^m$** $Mo^{92}$(9.5-Mev p) chem

$\gamma$ **0.390** $\alpha_K$ = 0.31 K/LM = 5.8 M4 sπ√2 ce$^-$, pe$^-$

Assignment from $Nb^{93}$(39-Mev $\alpha$), Mo(~0 to 20-Mev d); formerly assigned to $Tc^{92}$

H.T.Easterday, H.A.Medicus, Phys. Rev. 89, 752 (1953).

**$Tc^{96}$** (43 53, $52^m$)

$\tau_2$ **52$^m$** $Nb^{93}$(13.5-Mev $\alpha$) sπ√2 ce$^-$

$\beta^+$ ~0.01%

$\gamma$ IT **0.034** K/L = 1.2

Assignment from $Mo^{96}$(9.5-Mev p), Mo(4-Mev p); formerly assigned to $Tc^{94}$

H.T.Easterday, H.A.Medicus, Phys. Rev. 89, 752 (1953).

**$Tc^{99}$** (43 56, $5.9^h$)

$\tau$ (metal) **$6.04^h$** ic

$\tau$ dependent on chemical state

K.T.Bainbridge, M.Goldhaber, E.Wilson, Phys. Rev 90, 430 (1953).

**$Ru^{99}$** (44 55)

I **5/2** para

$\mu(Ru^{101})/\mu(Ru^{99}) = 1.09$

J.M.E.Griffiths, J.Owen, Proc. Phys. Soc. 65A, 951(1952).

I $\geq$5/2 or $\leq$9/2 S

$\mu$ is negative

K.Murakawa, J.Phys. Soc., Japan, 8, 535 (1953).

**$Ru^{101}_{44\ 57}$** I 5/2 para
$\mu(Ru^{101})/\mu(Ru^{99}) = 1.09$

J.H.E.Griffiths, J.Owen, Proc. Phys. Soc. 65A, 951(1952).

I ⩾5/2 or ⩽9/2 S
$\mu$ is negative

K.Murakawa, J. Phys. Soc., Japan, 8, 535 (1953).

**$Ru^{103}_{44\ 59}$** $\gamma$ (0.499) $\tau < 2 \times 10^{-9}$ s $\beta\gamma$

T.C.Engelder, Phys. Rev. 90, 259(1953).

Rh Neutron resonance (ev) cryst s
1.260±0.004 $\sigma_o$ = 5000±200
$\Gamma$ =0.156±0.005

V.L.Sailor, Phys. Rev. 91, 53; 90, 363A(1953).

**$Rh^{97}$ ?** $_{45\ 52}$ $\tau$ $31^m$ Ru(28-Mev d) chem
$\beta^+$

A.H.W.Aten, Jr., H.Cerfontain, W.Dzcubas, T.Hamerling, Physica 18, 972(1952).

**$Rh^{98}$ ?** $_{45\ 53}$ $\tau$ $9^m$ Ru(28-Mev d) chem
$\beta^+$ s

A.H.W.Aten, Jr., H.Cerfontain, W.Dzcubas, T.Hamerling, Physica 18, 972(1952).

**$Rh^{99}_{45\ 54}$** $\gamma$ 0.286 Ru(p); s$\pi$ ce$^-$

S.C.Fultz, R.J.Nash, R.L.Woodward, M.L.Pool, Phys. Rev. 88, 170A(1952).

**$Rh^{101}_{45\ 56}$** $\gamma$ 0.144 Ru(p); s$\pi$ ce$^-$
0.286
No $\beta^+$

S.C.Fultz, R.J.Nash, R.L.Woodward, M.L.Pool, Phys. Rev. 88, 170A(1952).

**$Rh^{104}_{45\ 59}$** $4.3^m$ $\gamma$ 14† 0.0511 K/L ⩾5 s$\pi$ ce$^-$
170† 0.0772 K/L ~0.6 scin
(0.051$\gamma$) ($\chi$) $\chi\chi$ Rh(pile n)
†Relative intensity ce$^-$

W.C.Jordan, J.M.Cork, S.B.Burson, Phys. Rev. 90, 862(1953).

$\gamma$ 0.052 $\alpha \sim 25$ pc, scin

J.M.Kahn, ORNL-1089(1951).

$_{44}$ $^s$ $\gamma$ 0.55 Rh(pile n);scin
w ~1.2

No (0.55$\gamma$) ($\chi$) No (0.55$\gamma$) ($\chi$)

W.C.Jordan, J.M.Cork, S.B.Burson, Phys. Rev.90, 862 (1953).

**$Rh^{104}_{45\ 59}$** Capture $\gamma$'s Rh(n,$\gamma$) scin
0.080
0.160

B.Hamermesh, V.Hummel, Phys. Rev. 88, 916(1952).

**$Rh^{106}_{45\ 61}$** $\gamma$ 100 † 0.51 scin
53 † 0.62
2 † 0.87
7 † 1.04
1 † 1.55
(0.62$\gamma$) (0.51$\gamma$) ($\theta$) and polarization-direction I = 0+, 2+, 0+
$\gamma\gamma(\theta)$ coefficients 12% lower than theory

J.J.Kraushaar, M.Goldhaber, Phys. Rev. 89, 1081 (1953).

Pd Relative abundances ms

| A | 102 | 104 | 105 |
|---|---|---|---|
| % | 0.96 | 10.97 | 22.23 |

| A | 106 | 108 | 110 |
|---|---|---|---|
| % | 27.33 | 26.71 | 11.81 |

J.R.Sites, G.Consolazio, R.Baldock, Phys. Rev. 92, 1096A (1953).

**$Pd^{105}_{46\ 59}$** I 5/2 S

J.Blaise, H.Chantrel, J. phys. radium 14, 135 (1953).

I 5/2 ? s
$\mu$ -0.57

A.Steudel, Z.Phys. 132, 429(1952).

**$Pd^{109}$ ?** $_{46\ 63}$ $4.8^m$ $\tau_1$ $5^m$ Pd(pile n)
$\gamma$ 0.17 $\alpha \sim 1$ scin

J.H.Kahn, ORNL-1089(1951).

**$Pd^{109}_{46\ 63}$** $13^h$ $\tau_2$ $13.6^h$ Pd(pile n);chem
Counted for 15 half-lives G-M counter

W.W.Meinke, Phys. Rev. 90, 410 (1953).

**$Pd^{112}_{46\ 66}$** $\gamma$ 0.018 U(28-Mev d)scin chem

R.Nussbaum, R.H.Wapstra, A.H.Verster, N.F.Cerfontain, H.Cerfontain, Physica 19,385 (1953).

Ag $\gamma$'s Ag(n,n'$\gamma$) $E_n$ = 2.7
1.1 scin
1.5

V.E.Scherrer, W.L.Smith, S.A.Allison, W.R.Faust, Phys. Rev. 91, 768 (1953).

Neutron resonance (ev) cryst s
5.24

H.H.Landon, V.L.Sailor, M.L.Foote, Jr., Phys. Rev. 90,363A(1953).

Neutron resonances (ev) $E_n$ = 12 ev to 5 kev

| | |
|---|---|
| 5.15 ± 0.03 | 52 |
| 15.9 $\sigma_o\Gamma^2$ = 23 | 66 |
| 29.6 | 125 |
| 40 | |

A.W.Merrison, E.R.Wiblin, Proc. Roy. Soc. 215A, 278(1952).

**Ag** Neutron resonances (ev) $E_n$ = 15 to 100 ev

| | | | |
|---|---|---|---|
| 16.5 | 40 | 52 | 71 |
| 30.7 | 43 | 56 | 88 |

J.S.Levin, W.Y.Kato, N.G.Sjostrand, D.J.Hughes, Phys. Rev. 90,363A(1953).

**$Ag^{104}_{47\ 57}$**

| | | | | |
|---|---|---|---|---|
| $\tau$ | | $27^m$ | d $59^mCd$ | |
| $\beta^+$ | | 2.70 | | s$\pi$ |
| $\gamma$ | | 0.555 | | |

Number of weaker $\gamma$'s tentatively assigned to $Ag^{104}$

F.A.Johnson, Proc. Roy. Soc. Canada 46, 135A (1952).

**$Ag^{106}_{47\ 59}$ $8.6^d$**

No $\beta^+$ (<1% of $\epsilon$) scin

W.L.Bendel, F.J.Shore, H.N.Brown, R.A.Becker, Phys. Rev. 90, 88 (1953).

**$24.5^m$**

| | | | | |
|---|---|---|---|---|
| $\tau_2$ | | $24.0^m$ | Ag(22-Mev$\gamma$) | |
| $\beta^+$ | 17% | 1.45 | | s$\pi$2 |
| | 83% | 1.96 | | |
| $\beta^-$(?) | <1% | 0.36 | | |
| $\gamma$ | 17% | 0.512 | $\alpha_K \sim 3\times10^{-3}$ | scin, ce$^-$ |

$\epsilon_K/(0.512\gamma$+annhil $\gamma$'s) = 0.28

High energy photons probably bremsstrahlung

W.L.Bendel, F.J.Shore, H.N.Brown, R.A.Becker, Phys. Rev. 90, 888 (1953).

**$Ag^{107}_{47\ 60}$ Stable**

$\mu(Ag^{107})/\mu(Ag^{109}) = 0.86627$ M

G.Wessel, H.Lew, Phys. Rev. 91,476A(1953).

**$Ag^{109}_{47\ 62}$ $39^s$**

$\gamma$ (0.087) $\alpha_K \sim 8$ d $13^hPd$ scin

R.Nussbaum, R.H.Wapstra, A.H.Verster, N.F.Cerfontain, H.Cerfontain, Physica 19,385 (1953).

stable $\mu(Ag^{107})/\mu(Ag^{109}) = 0.86627$ M

G.Wessel, H.Lew, Phys. Rev. 91,476A(1953).

**$Ag^{110}_{47\ 63}$ $270^d$**

(0.53$\beta$) (0.66$\gamma$, 0.89$\gamma$, 0.94$\gamma$)
No(0.53$\beta$) (1.52$\gamma$, 1.39$\gamma$)
(0.66$\gamma$) (0.89, 0.94$\gamma$, 1.39$\gamma$)
(0.89$\gamma$) (0.94$\gamma$, 1.39$\gamma$)
(1.52$\gamma$) (0.66$\gamma$, 0.76$\gamma$) No(1.52$\gamma$) (0.89$\gamma$)

Results in agreement with Siegbahn decay scheme

S.A.E.Johansson, S.Almquist, Arkiv Fysik 5, 427 (1952).

**$Ag^{110}$ ?** $_{47\ 63}$ Capture $\gamma$ Ag(n,$\gamma$) scin

0.187

B.Hamermesh, V.Hummel, Phys. Rev. 88, 916(1952).

**$Ag^{111}_{47\ 64}$** $\bar{E}_\beta = 0.376 \pm 0.014$ ic

J.M.Brabant, L.W.Cochran, R.S.Caswell, Phys. Rev. 91,210A(1953).

**$Ag^{112}_{47\ 65}$**

| | | | | |
|---|---|---|---|---|
| $\beta^-$ | 15% | ~1 | U(28-Mev d) | a |
| | 20% | 2.7 | chem | $\alpha$s$\gamma$ |
| | 40% | 3.5 | | |
| | 25% | 4.1 | | |
| $\gamma$ | | 0.62 | | scin |

No (4.1$\beta$) ($\gamma$)

R.Nussbaum, R.H.Wapstra, A.H.Verster, N.F.Cerfontain, H.Cerfontain, Physica 19,385 (1953).

**Cd** Neutron resonance (ev)

0.180 $\sigma_o$ = 7800 $\Gamma$ = 0.113

B.N.Brockhouse, Can. J. Phys. 31, 432 (1953).

Neutron resonances (ev) $E_n$ = 1 to 4000 ev

| | | | |
|---|---|---|---|
| | 18.0 | | |
| st | 27.2 | $Cd^{111}$ | $\sigma_o\Gamma^2$ = 35 |
| | 66.6 | $Cd^{112}$? | |
| st | 88.2 | $Cd^{110}$? | |
| | 122 | $Cd^{116}$? | |
| | 163 | | |
| | 234 | | |
| | 400 | | |
| | 840 | | |

R.R.Palmer, L.M.Bollinger, Phys. Rev. 91,480A (1953); verbal report.

**$Cd^{104}_{48\ 56}$**

| | | | |
|---|---|---|---|
| $\tau$ | $59^m$ | Ag(50-Mev p) | chem |
| $\beta^+$ | 0.93 | | s$\pi$ |
| $\gamma$ | 0.0666 | | |
| | 0.0835 | | |
| w | 0.1498 | | |

F.A.Johnson, Proc. Roy. Soc. Canada 46, 135A (1952).

**$Cd^{105}_{48\ 57}$**

| | | | |
|---|---|---|---|
| $\tau$ | $55^m$ | Ag(35-Mev p) | chem |
| $\beta^+$ | 1.68 | | s$\pi$ |
| $\gamma$ | 0.0254 | (K x ray?) | |
| | 2.1 | | |

F.A.Johnson, Proc. Roy. Soc. Canada, 46, 135A (1952).

**$Cd^{111}_{48\ 63}$** |q| (0.247 level)~0.5 single In cryst $\gamma\gamma(\theta)$

H.Albers-Schönberg, K.Alder, O.Braun, E.Herr, T.B.Novey, Phys. Rev. 91, 1287 (1953).

Levels $Cd(n,n')49^mCd$ $E_n$ = 0.1 to 1.4

0.72
0.95 ?
1.15

Absolute $\sigma$ consistent with I = 11/2 for $49^mCd$ from statistical model

A.E.Francis, J.J.McCue, C.Goodman, Phys. Rev. 89, 1232(1953).

**$Cd^{114}_{48\ 66}$** Capture $\gamma$'s Cd(n,$\gamma$) s$\pi$ ce$^-$

0.097
0.562

C.T.Hibdon, C.O.Muehlhause, Phys. Rev. 88, 943 (1952); 87, 222A(1952).

**$Cd^{114}$** 48 66

Capture $\gamma$'s Cd(n,$\gamma$) sl $pe^-$

| | | | |
|---|---|---|---|
| $89^+$ | **0.555** | $11^+$ | **0.80** |
| $25^+$ | **0.646** | $20^+$ | **1.30** |

$^+$Photons per 100 n captures

H.T.Motz, Phys. Rev. 90,355A(1953); verbal report.

Capture $\gamma$'s Cd(n,$\gamma$) scin

**0.558**
**8.5**

B.Hamermesh, V.Hummel, Phys. Rev. 88, 916(1952).

Capture $\gamma$'s Cd(n,$\gamma$) 2 cryst scin s

| | |
|---|---|
| $33^+$ | 0.88 |
| $13^+$ | 1.33 |
| $38^+$ | 1.61 |
| $28^+$ | 2.44 |
| $34^+$ | 3.61 |
| | 4.67 |
| | 5.17 |

W.A.Reardon, R.W.Krone, R. Stump, Phys. Rev.91, 442A; 334 (1953).

Capture $\gamma$'s Cd(n,$\gamma$) pair s

| | | | |
|---|---|---|---|
| $0.36^+$ | **6.82** | $0.12^+$ | **7.84** |
| $0.21^+$ | **7.67** | $0.23^+$ | **8.48** |
| $0.18^+$ | **7.73** | $0.14^+$ | **9.05** |

$^+$Photons per 100 n captures

G.A.Bartholomew, B.B.Kinsey, Phys. Rev. 90, 355A(1953).

**$Cd^{116}$** 48 68

$\tau_{\beta\beta}$ **$>8\times10^{15}$ y** ppl

Assuming decay energy $\geq 2$ Mev

J.H.Fremlin, M.C.Walters, Proc Phys. Soc. 65A, 911(1952).

**$Cd^{117}$** 48 69 $2.8^h$

$\tau_1$ **$2.9^h$** Cd(d,p) chem

$\gamma$ **1.2** a

A.H.W.Aten, Jr., M.Boelhouwer, Physica 18, 651 (1952).

$\tau_1$ **$3.0^h$** Cd(n,$\gamma$) Cd(d,p) U(n,f)

$\beta^-$ weak if present

C.D.Coryell, P.Lévêque, H.G.Richter, Phys. Rev. 89, 903A(1953).

$\sim 50^m$ $\tau_2$ **$\sim 50^m$** Cd(n,$\gamma$) Cd(d,p) U(n,f)

$\beta^-$ and $\gamma$ p $\sim 2^h$ In ?

C.D.Coryell, P.Lévêque, H.G.Richter, Phys. Rev. 89, 903A(1953).

**$Cd^{118}$** 48 70

$\tau$ **$\sim 30^m$** U(n,f)

$\beta^-$ a

Not p $4.5^m$In

C.D.Coryell, P.Lévêque, H.G.Richter, Phys. Rev. 89, 903A(1953).

In Neutron resonance (ev)

1.458 $\sigma_o$=27,000 $\Gamma$=0.114
$\sigma_{so}$=1,600 $\Gamma_n/\Gamma$ = 0.045

L.B.Borst, Phys. Rev. 90, 859 (1953).

**$In^{110}$** 49 61 $4.9^h$

$\tau_1$ **$4.9^h$** Ag(20-Mev $\alpha$)

$\gamma$ IT 195* **0.121** K/LM=4.5 chem; sl $ce^-$
100* **0.657**
42* **0.884**
27* **0.937**

* Relative intensity of $ce^-$

E.Bleuler, J.W.Blue, S.A.Chowdary, A.C.Johnson, D.J.Tendam, Phys. Rev. 90, 464 (1953).

$65^m$ $\beta^+$ **2.25** Ag(20-Mev $\alpha$) sl
$\gamma$ **0.656** chem sl $ce^-$
(2.25$\beta$) ($\gamma$) No 2.9$\beta^+$ (<3%) a$\beta\gamma$

E.Bleuler, J.W.Blue, S.A.Chowdary, A.C.Johnson, D.J.Tendam, Phys. Rev. 90, 464 (1953).

**$In^{111}$** 49 62

$\gamma$ **0.1708** K/LM= 7.0 s
**0.2456** K/LM= 4.8

G.A.Graves, L.W.Langer, R.D.Moffat, Phys. Rev. 88, 169A and 344(1952).

$\gamma\gamma(\theta)$ b = - 0.19 liquid sample

b depends on phase not chemical structure

R.M.Steffen, Phys. Rev. 89, 903A(1953).

**$In^{112}$** 49 63 $23^m$

$\tau_1$ **$20.7^m$** Ag(20-Mev $\alpha$) chem

$\gamma$ **0.155** $\alpha$ large K/LM = 3.7 sm

E. Bleuler, J.W.Blue, S.A.Chowdary, A.C.Johnson, D.J. Tendam, Phys. Rev. 90, 464 (1953).

$9^m$ $\tau_2$ **$14.5^m$** d $21^m$In Ag(20-Mev $\alpha$)

$\beta^-$ 44% **0.656** s
$\beta^+(+\epsilon)$ 56% **1.52**
No $\beta\gamma$

E.Bleuler, J.W.Blue, S.A.Chowdary, A.C.Johnson, D.J.Tendam, Phys. Rev. 90, 464 (1953).

**$In^{113}$** 49 64 $1.7^h$

$\gamma$ **0.3917** K/LM = 4.2 s

G.A.Graves, L.W.Langer, R.D.Moffat, Phys. Rev. 88, 169A and 344(1952).

**$In^{113}$** 49 64

$\mu$ **5.4966** $In(NO_3)_3$; I

$\mu(In^{113})/\mu(In^{115}) = 0.99787 \pm 0.00004$

Y.Ting, D.Williams, Phys. Rev. 89, 595(1953).

**$In^{114}$** 49 65 $50^d$

$\gamma$ **0.1898** K/LM = 1.00 s

G.A.Graves, L.W.Langer, R.D.Moffat, Phys. Rev. 88, 169A and 344(1952).

$\beta^-$ **2.01** $50^d$In; s

$72^s$

V.S.Shpinel, N.V.Forafontov, Zhur. Ekspti' i Teoret. Fiz. 21, 1376(1951).

($\beta$)(possible 1.2$\gamma$) <0.3% of $\beta$'s a$\beta\gamma$

R.M.Nussbaum, R.Van Lieshout, Physica 19,451. (1953).

$\gamma\gamma(\theta)$; I = 2,2,0 or 4,2,0 $50^d$In metallic

$\gamma$ cascade follows $\epsilon$ decay of $72^s$ state

R.M.Steffen, W.Zobel, Phys. Rev. 88, 170A(1952).

**$In^{115}$** 49 66 — stable

$\gamma$ **0.3346** K/LM = 3.8 s

G.A.Graves, L.M.Langer, R.D.Moffat, Phys. Rev. 88, 169A and 344(1952).

$\mu$ **5.5083** $In(NO_3)_3$ $ScCl_3$; I

$\nu(In^{115})/\nu(Sc^{45}) = 0.901877 \pm 0.00005$

Y.Ting, D.Williams, Phys. Rev. 89, 595(1953).

**$In^{116}$** 49 67 — $54^m$

$\tau_1$ **$54.14^m \pm 0.07$** In(pile n)

Counted for 5 half-lives with G-M

K.W.Downes, G.A.Price, R.Sher, V.J.Walsh, BNL-216 (T-33).

$\tau_1$ **$53.99^m \pm 0.06$** In(pile n)

Counted for 6 half-lives with $\beta$ electroscope

E.E.Lockett, R.H.Thomas, Nucleonics 11, No. 3, 14(1953).

**$In^{116}$ ?** 49 67 — Capture $\gamma$'s $In(n,\gamma)$ scin

**0.160**

**0.256**

No crossover observed

B.Hamermesh, V.Hummel, Phys. Rev. 88, 916(1952).

**$In^{117}$** 49 68 — $70^m$

$\tau_1$ **$70^m$** U(n,f)

$\beta^-$ and weak $\gamma$ a

C.D.Coryell, P.Lévêque, H.G.Richter, Phys. Rev. 89, 903A(1953).

$\sim 2.5^h$

$\tau_2$ **$\sim 2.5^h$** U(n,f)

$\beta^-$ and very weak $\gamma$ a

C.D.Coryell, P.Lévêque, H.G.Richter, Phys. Rev. 89, 903A(1953).

**$In^{118}$** 49 69 — $< 1^m$

$\tau_2$ **$< 1^m$** d $30^m$Cd chem

$\beta^-$ **4.0** a

C.D.Coryell, P.Lévêque, H.G.Richter, Phys. Rev. 89, 903A(1953).

**$Sn^{113}$** 50 63 — $112^d$

$\tau$ **$120^d$** Sn(pile n) chem

No 0.255$\gamma$ (< 1% of 0.39$\gamma$) scin

No 0.401$\gamma$ (< 10% of 0.39$\gamma$)

Y.Deschamps, P.Avignon, Compt. rend. 236, 478 (1953).

No $e^-$(0.085$\gamma$) < 1% of $e^-$(0.392$\gamma$) sl

No $e^-$(0.255$\gamma$) < 1% of $e^-$(0.392$\gamma$)

$e^-$(0.401$\gamma$) not resolvable

$e^-$(Auger)/[$e^-_{KLM}$(0.392$\gamma$)] = 0.56

$\epsilon_L/\epsilon_K$ = 0.08 to 0.17 (if all $\epsilon$ to 0.392 level)

Previous value of 0.8 superseded

C.D.Broyles, D.A.Thomas, S.K.Haynes, Phys. Rev. 89, 715(1953).

**$Sn^{124}$** 50 74 — $\tau_{\beta\beta}$ $>1.5\times10^{17}y$ 95% $Sn^{124}$ scin

J.A.McCarthy, Phys. Rev. 90, 853 (1953).

**$Sn^{124}$** 50 74 — $\tau_{\beta\beta}$ $>2\times10^{15}y$ ppl

Assuming decay energy $\geq$2 Mev

J.H.Fremlin, M.C.Walters, Proc. Phys. Soc. 65A, 911(1952).

**$Sb^{116}$** 51 65

$\tau$ **$15.5^m$** Sn(>5-Mev p) chem

$\beta^+$ **2.40*** not Sb($\leq$31-Mev $\gamma$)

$\gamma$ **0.90*** sl $pe^-$

**1.30***

**2.20*** sl Cpt

$\beta^+$ and $\gamma$'s formerly assigned to $16.6^m Sb^{120}$, q.v.

No $60^m$Sb found from Sn(6.8-Mev p) chem

P.Stähelin, P.Preiswerk, Nuovo Cim. 10, 1219 (1953). *Data of J.P.Blaser, F.Boehm, P.Marmier, Helv. Phys. Acta 23, 623 (1950).

**$Sb^{120}$** 51 69 — $16.6^m$

$\tau$ **$16.6^m$** Sn(5-Mev p) chem

$\beta^+$ (1.70)* Sb($\leq$31-Mev $\gamma$)

No $\gamma$ ($E_\gamma > 0.60$) scin

$\gamma$'s previously assigned here not produced by Sb($\leq$ 31-Mev $\gamma$). Now assigned to $Sb^{116}$, q.v.

P.Stähelin, P.Preiswerk, Nuovo Cim. 10, 1219(1953). *J.P.Blaser, F.Boehm, P.Marmier, Helv. Phys. Acta 23, 623 (1950).

**$Sb^{121}$** 51 70

q **-1.3** S

G.Sprague, D.H.Tomboulian, Phys. Rev. 92,105; 91, 476A (1953).

**$Sb^{122}$** 51 71 — $3.5^m$

$\gamma$ **0.059** $\alpha(0.059\gamma\ ?) \sim 25$

**0.074** $Sb^{121}$(pile n); pc

J.H.Kahn, ORNL-1089(1951).

**$Sb^{123}$** 51 72

q **-1.7** S

G.Sprague, D.H.Tomboulian, Phys. Rev. 92,105; 91, 476A (1953).

**$Sb^{124}$** 51 73 — $60^d$

| | | | |
|---|---|---|---|
| $\beta^-$ | 14% | **0.24** | s $\pi$ |
| | 49% | **0.61** | |
| | 9% | **0.966** | |
| | 7% | **1.602** | |
| | 21% | **2.317** | F-K plot not linear |

$2.3\beta$ $\Delta I = 1$, yes ? Not $\Delta I = 2$, yes

| | | | |
|---|---|---|---|
| $\gamma$ | | **0.603** | $\alpha$=0.0034 K/LM=7.9 E2 $ce^-$ |
| | | **0.641** | $pe^-$ |
| | | **0.716** | |
| | | **1.68** | |
| | | **2.09** | |

(1.68$\gamma$)(0.60$\gamma$) (2.09$\gamma$)(0.60$\gamma$)

L.M.Langer, N.H.Lazar, R.J.D.Moffat, Phys. Rev. 91, 338; 91, 485A (1953).

| | | | |
|---|---|---|---|
| $\beta^-$ | 10% | **0.223** | S |
| | 53% | **0.609** | |
| | 6% | **0.871** | |
| | 5% | **1.581** | |
| | 5% | **1.658** | F-K plot not linear |
| | 21% | **2.306** | F-K plot not linear |

$2.3\beta$ $\Delta I = 2$, no ? Not $\Delta I = 2$, yes

| | | |
|---|---|---|
| $\gamma$ | | Rel. intensity of $ce^-$ |
| | **0.604** | K : L : M = 100 : 13 : 3 |
| | **0.648** | K = 6.4 |
| | **0.711 ?** | |

**$Sb^{124}_{51\ 73}$** $60^d$

| | | | |
|---|---|---|---|
| | **0.725** | K = 7.6 | |
| | **1.697** | K = 3.4 | |

E.P.Tomlinson, S.L.Ridgway, K.Gopalakrishnan, Phys. Rev. 91, 484A (1953).

| | | | |
|---|---|---|---|
| $\beta^-$ | (0.95) | $\Delta I = 2$, yes shape? | sl |
| | **2.27** | $\Delta I = 2$, yes shape | |
| | $\alpha_K$ | K/L | |
| $\gamma$ | (0.607) 0.0036 | 7.1 | E2 |
| | (1.7) | $\leqslant 5 \times 10^{-4}$ | |

D.R.Hutchinson, M.L.Wiedenbeck, Phys. Rev. 88, 699(1952).

| | | | |
|---|---|---|---|
| $\gamma$ | **0.607** | K/LM ~ 15 | s ce$^-$ |

R.E.Maerker, R.D.Birkhoff, Phys. Rev. 89, 1159 (1953).

| | | | |
|---|---|---|---|
| $\gamma$ | (0.60) | $\tau < 2 \times 10^{-9}$ s | $\beta\gamma$ |

T.C.Engelder, Phys. Rev. 90, 259(1953).

| | | | | | |
|---|---|---|---|---|---|
| $\gamma$ | $154^+$ | **0.60** | $17^+$ | **1.35** | s $\pi$ Cpt |
| | $19^+$ | **0.71** | $100^+$ | **1.69** | |
| | $6.6^+$ | **0.96** | $10^+$ | **2.07** | |
| | $4.4^+$ | **1.05** | | | |

K.Gromov et al., Doklady Akad. Nauk SSSR 86, 255(1952).

| | | |
|---|---|---|
| $\gamma$ | **1.692** | sl pe$^-$ |

D.E.Alburger, Phys. Rev. 88, 1257(1952).

No $\gamma\gamma(\theta)$, no $\gamma\gamma$ polarization - direction scin
$(2.27\beta^-)(0.60\gamma)(\theta)$, polarization - direction
I = 3, 2+, 0+

R.M.Kloepper, E.S.Lennox, M.L.Wiedenbeck, Phys. Rev. 88, 695(1952).

$(2.27\beta^-)(0.60\gamma)$ polarization-direction
$0.60\gamma$ no parity change

D.R.Hamilton, A.Lemonick, F.M.Pipkin, Phys. Rev. 90, 370A (1953).

| | | | | |
|---|---|---|---|---|
| $\gamma$ | (1.70) | (E)1 | 99.9% | $\gamma\gamma(\theta)$ |
| | | $\alpha = 2.6 \times 10^{-4}$ | | E1 |

$(1.70\gamma)(0.60\gamma)(\theta)$ I = 3,2,0
I(2.3 level $Te^{124}$) = 3 -
$(2.06\gamma)(0.60\gamma)(\theta)$ I = 3,2,0

F.R.Metzger, Phys. Rev. 90, 328(1953).

| | | | | |
|---|---|---|---|---|
| $\gamma$ | (1.70) | (E)1 | 99.9% | $\gamma\gamma(\theta)$ |

$(1.70\gamma)(0.60\gamma)(\theta)$ I = 3,2,0

J.J.Kraushaar, M.Goldhaber, Phys. Rev. 89, 1081 (1953).

$(0.60\gamma)(2.27\beta)$ Sb(pile n); scin
$(0.60\gamma)(1.70\gamma)$ $(0.60\gamma)(2.06\gamma)$ ?
$(0.60\gamma)(0.65\gamma$ and/or $0.73\gamma)$

S.A.E.Johansson, S.Almquist, Arkiv Fysik 5, 427 (1952); Nature 170, 583(1952).

**$Te^{123}_{52\ 71}$** $100^d$

| | | | |
|---|---|---|---|
| $\gamma$ | (0.159) | $\tau = 1.9 \times 10^{-10}$ s | $e^-_K e^-_K$ |

R.L.Graham, R.E.Bell, Can. J. Phys. 31, 377(1953).

**$Te^{124}$ ?** $_{52\ 72}$

| | | | |
|---|---|---|---|
| Capture $\gamma$ | Te(n,$\gamma$) | | scin |
| | **0.609** | | |

B.Hamermesh, V.Hummel, Phys. Rev. 88, 916(1952).

**$Te^{125}_{52\ 73}$** $58^d$

| | | | |
|---|---|---|---|
| $\gamma$ | (0.035) | $\tau = 1.8 \times 10^{-9}$ s | $e^-_L e^-_L$ |

R.L.Graham, R.E.Bell, Can. J. Phys. 31, 377(1953).

**$Te^{125}_{52\ 73}$**

| | | | |
|---|---|---|---|
| $\gamma$ | **0.0355** | $\alpha_K = 160$ | pc |
| | | K : L : M = 5.4 : 3.6 : 1.0 | |
| | **0.110** | $\alpha_K = 11$ | |
| | | K : L : M = 40 : 5.5 : 1.0 | |

J.G.Balfour, quoted by S.C.Curran, Physica 18, 1161(1952).

**$Te^{130}_{52\ 78}$**

| | | |
|---|---|---|
| $\tau_{\beta\beta}$ | $>10^{17}$y | Te chem |

H.D. Sharma, Curr. Sci. 22, 45 (1953).

**$Te^{130}_{52\ 78}$**

| | | |
|---|---|---|
| $\tau_{\beta\beta}$ | $>4 \times 10^{15}$y | ppl |

Assuming decay energy $\geqslant 2$ Mev

J.H.Fremlin, M.C.Walters, Proc. Phys. Soc. 65A, 911(1952).

**$Te^{131}_{52\ 79}$** $25^m$

| | | | | |
|---|---|---|---|---|
| $\tau_2$ | | **24.8$^m$** | Te(n,$\gamma$) | chem |
| $\beta^-$ | 45% | **1.35** | | a$\beta\gamma$ |
| | 55% | **2.0** | | a |
| $\gamma$ | 30† | **0.16** | | a |
| | 20† | **0.7** | | |

$\gamma\gamma$ $\beta\gamma$

K.Geiger, Z. Naturforsch. 7a, 579(1952).

I

| | | |
|---|---|---|
| Neutron resonances (ev) | | $E_n$ = 5 ev to 5 kev |
| **19.4** | $\sigma_o\Gamma^2$ = 23 | |
| **29.6** | | |
| **43** | | |

A.W.Merrison, E.R.Wiblin, Proc. Roy. Soc. 215A, 278(1952).

**$I^{121}_{53\ 68}$**

| | | |
|---|---|---|
| $\tau$ | **1.5$^h$** | d 40$^m$Xe, p 17$^d$Te |

B.Dropesky, E.O.Wiig, Phys. Rev. 88, 683(1952).

**$I^{122}_{53\ 69}$**

| | | |
|---|---|---|
| $\tau$ | **3.4$^m$** | d 20$^h$Xe |

B.Dropesky, E.O.Wiig, Phys. Rev. 88, 683(1952).

**$I^{125}_{53\ 72}$**

| | | |
|---|---|---|
| $\gamma$ | **0.0354** | d 18$^h$Xe; sl ce$^-$ |

$e^-$(Auger)/$[e^-_{LM}(0.035\gamma)]$ = 1.3
shows $\epsilon$ chiefly to 0.035 level

I.Bergström, Arkiv Fysik 5, 191(1952).

**$I^{126}_{53\ 73}$**

| | | | |
|---|---|---|---|
| $\beta^-$ | 72.5 † | **0.87** | I(28-Mev d); sl |
| | 27.5 † | **1.26** | |
| $\beta^+$ | 2.7 † | **1.21** | |
| $\gamma$ | | | sl ce$^-$, pe$^-$ scin |
| | **0.390** | $\alpha_K = 0.016$ K/LM $\geqslant 8$ | E2 |
| | **0.67** | | |

$\epsilon_K/(0.67\gamma) \sim 1.25$* $(0.39\gamma)/(0.67\gamma) \sim 1.0$
$(\sim 0.9\beta^-)(0.39\gamma)$ (K x ray)$(0.67\gamma)$

*From comparison with $Cs^{137}$ K x ray/$\gamma$ value

N.Marty, M.Langevin, P.Hubert, Compt. rend 236, 1153(1953).

$I^{127}_{53}$ $^{74}$ $|q|$ **0.69** quad res

T.Kamei, J. Phys. Soc. Japan 7, 649(1952).

Level $I(n,n'\gamma)$ $E_n$=14 scin
$\gamma$'s 0.7-0.8 $n'\gamma$
No other $\gamma$'s observed

R.E.Garrett, F.L.Hereford, B.W.Sloope, Phys.Rev. 91, 441A (1953); verbal report.

$I^{128}_{53}$ $^{75}$ $\gamma$ 100† **0.455** scin
2† **0.98**

A.H.Wapstra, N.F.Verster, M. Boelhouwer, Physica 19, 138 (1953).

$I^{129}_{53}$ $^{76}$ $q(I^{129})/q(I^{127})$= 0.701213 $SnI_4$; quad res
±0.000015

R.Livingston, H.Zeldes, Phys. Rev. 90, 609(1953).

$\beta^-$ **0.150** $\Delta I$= 2, no s
$\gamma$ **0.038** $\alpha_K$= 19 M1
No 0.188 $\beta$ (< 1%) scin

E.der Mateosian, C.S.Wu, Phys. Rev. 91, 497A, (1953); verbal report.

$I^{131}_{53}$ $^{78}$ $\tau$ $8.07^d$±0.02 electroscope
Counted 3 samples for ~6 half-lives

H.H.Seliger, L. Cavallo, S.V.Culpepper, Phys. Rev. 90, 443 (1953).

$\tau$ **$8.05^d$** ± 0.01 U(n,f)

R.M.Bartholomew, E.Brown, R.C.Hawkins, W.F. Merritt, L.Yaffe, Can. J. Chem. 31, 120(1953).

$\tau$ **$8.06^d$** ± 0.02

E.E.Lockett, R.H.Thomas, Nucleonics 11, No. 3, 14(1953).

$\gamma$ **0.080164** ± 0.000009 cryst
**0.284307** ± 0.000049
**0.364467** ± 0.000050
Results of new measurement using 1952 calibration

H.C.Hoyt, J.W.M.DuMond, Phys. Rev. 91, 1027(1953).

| $\gamma$ | | $\alpha_K$* | K/LM | sl pe⁻ ce⁻ |
|---|---|---|---|---|
| 6† | (0.284) | 0.05 | 3.3 | E2 |
| 100† | (0.364) | 0.02 | 5.6 | E2 |
| 10† | (0.638) | $\alpha$ = 0.004 | | E2 |
| 3† | (0.723) | $\alpha$ = 0.003 | | E2 |

*Based on $\alpha_K$ = 0.097 for 0.662$\gamma$ of $Cs^{137}$

J.R.Haskins, J.D.Kurbatov, Phys. Rev. 88, 884 (1952).

$\gamma$ (0.637) $\alpha_K$=0.0040 E2 s $ce^-$, $pe^-$
(0.722) $\alpha_K$=0.0031 E2

J.L.Wolfson, Can. J. Phys. 30, 715(1952).

(0.284$\gamma$) (0.080$\gamma$) No other $\gamma\gamma$ scin

S.Almqvist, S.A.E.Johansson, Nature 170, 583 (1952).

$I^{131}_{53}$ $^{78}$ No (0.638$\gamma$) (0.080$\gamma$) a$\gamma\gamma$
(0.284$\gamma$) (0.080$\gamma$) ($\theta$) isotropic scin

D.Schiff, F.R.Metzger, Phys. Rev. 90, 849 (1953).

$I^{133}_{53}$ $^{80}$ $\tau$ **$20.8^h$** ± 0.2 U(n,f); chem

S.Katcoff, W.Rubinson, Phys. Rev. 91,1458(1953).

$I^{134}_{53}$ $^{81}$ Mass assignment of $54^m$ activity confirmed from U(n,f) cumulative yield of 7.7% ($Xe^{132}$ yield = 4.2%, $Xe^{134}$ yield = 8.2%; ms)

L.Yaffe, A.E.Day, B.A.Greer, Can. J. Chem 31, 48(1953).

Xe Neutron resonances (ev) $E_n$ = 1.5 ev to 2 kev
**9.3**
**13.9** $\sigma_o\Gamma^2 \sim 1000$

S.P.Harris, Phys. Rev. 89, 904A(1953).

$Xe^{121}_{54}$ $^{67}$ $\tau$ **$40^m$** p $1.5^h$I, I(240-Mev p) chem

B.Dropesky, E.O.Wiig, Phys. Rev. 88, 683(1952).

$\tau$ **$70^m$** I(80-Mev p) chem

D.E.Tilley, Proc. Roy. Soc. Canada 46, 135A(1952).

$Xe^{122}_{54}$ $^{68}$ $\tau$ **$20^h$** p $3.4^m$I, I(240-Mev p) chem

B.Dropesky, E.O.Wiig, Phys. Rev. 88, 683(1952).

$\tau$ **$19.5^h$** p $3.4^m$I, I(80-Mev p) chem

D.E.Tilley, Proc. Roy. Soc. Canada 46, 135A(1952).

$Xe^{123}_{54}$ $^{69}$ $\tau$ **$1.7^h$** p $13^h$I, I(240-Mev p) chem

B.Dropesky, E.O.Wiig, Phys. Rev. 88, 683(1952).

$\tau$ **$2.1^h$** I(50-Mev p) chem

D.E.Tilley, Proc. Roy. Soc. Canada 46, 135A(1952).

$Xe^{125}_{54}$ $^{71}$ $\tau$ **$18.0^h$** Xe(pile n) ms
$\epsilon$ from ratio of Auger $e^-$ to $ce^-_K$

| $\gamma$ | | | | |
|---|---|---|---|---|
| | 68* | 0.054 | K/LM = 4.2 | sl, |
| | 1* | 0.096 | K/LM = 5 | $ce^-$ |
| | 1* | 0.106 | K/LM = 5 | |
| | 24* | 0.187 | K/LM = 4.5 | |
| | 7* | 0.243 | K/LM = 7 | |
| | vw | 0.46 | | scin |

*Relative intensity of $ce^-_K$

I.Bergström, Arkiv Fysik 5, 191(1952).

$Xe^{127}_{54}$ $^{73}$ $^{34^d}$ $\tau_2$ **$25^d$** Xe(pile n) ms
$\epsilon$ from ratio of Auger $e^-$ to $ce^-_K$

| $\gamma$ | | | | |
|---|---|---|---|---|
| | 34* | 0.057 | K/LM = 6.2 | sl, |
| | 21* | 0.145 | | $ce^-$ |
| | 41* | 0.170 | | |
| | 84* | 0.2026 | K/LM = 4.7 | s $\pi/2$ |
| | vw | 0.365 | | scin |

*Relative intensity of $ce^-_K$

I.Bergström, Arkiv Fysik 5, 191(1952).

**$Xe^{131}$** 54 77 — $12^d$

| | | | | | |
|---|---|---|---|---|---|
| $\tau$ | | $12.0^d$ | | d $8^d$I | ms |
| $\gamma$ | | 0.1639 | $\alpha_K = 38$ K/L = 2.3 L/M = 2.9 | M4 | $s\pi\downarrow 2$ |

I.Bergström, Arkiv Fysik 5, 191(1952).

**stable**

| | | | | |
|---|---|---|---|---|
| q | | -0.12 | | S |
| $\mu$ | | +0.683 | | S |

A.Bohr, J.Koch, E.Rasmussen, Arkiv Fysik 4, 455 (1952).

**$Xe^{133}$** 54 79 — $5.3^d$

| | | | | | |
|---|---|---|---|---|---|
| $\tau$ | | $5.4^d$ | Xe(pile n) | U(n,f) | ms |
| $\beta^-$ | | 0.347 | | | sl |
| $\gamma$ | | 0.081 | $\alpha_K = 1.5$ K/LM = 4.9 | M1 | |

$[e^-(0.08\gamma)][\beta]$

I.Bergström, Arkiv Fysik 5, 191(1952).

**$Xe^{133}$** 54 79

| | | | | |
|---|---|---|---|---|
| $\gamma$ | | (0.08) | $\alpha_K = 1.8$ K/LM = 6 $\tau = 6 \times 10^{-9}$s | M1 $\beta^- e_K^-$ |

R.L.Graham, R.E.Bell, Can. J. Phys. 31, 377(1953).

**$Xe^{135}$** 54 81 — $9.2^h$

| | | | | | |
|---|---|---|---|---|---|
| $\tau_2$ | | $9.13^h$ | | U(n,f) | chem |

F.Brown, L.Yaffe, Can. J. Chem. 31, 242(1953).

| | | | | | |
|---|---|---|---|---|---|
| $\tau_2$ | | $9.2^h$ | Xe(pile n) | U(n,f) | ms |
| $\beta^-$ | | 0.91 | | | sl |
| $\gamma$ | 100† | 0.25 | $\alpha_K = 0.054$ K/LM = 6.5 | M1,E2 | sl ce$^-$, scin |
| | e† | 0.61 | | | scin |

$[e^-(0.25\gamma)][\beta]$

0.053, 0.148, 0.190 $\gamma$'s not found

I.Bergström, Arkiv Fysik 5, 191(1952).

| | | | | |
|---|---|---|---|---|
| $\gamma$ | (0.25) | $\tau = 2.8 \times 10^{-10}$s K/LM = 5.6 | $\beta^- e_K^-$ | |

R.L.Graham, R.E.Bell, Can. J. Phys. 31, 377(1953).

**$Xe^{145}$** 54 91

Existence of 0.8$^s$Xe activity in doubt
Previously reported as p $1.8^h Ce^{145}$, q.v.

A.A.Caretto, Jr., S.Katcoff, Phys. Rev. 89, 1267 (1953).

**$Cs^{127}$** 55 72

| | | | | |
|---|---|---|---|---|
| $\gamma$ | | 0.125 | I(56-Mev $\alpha$) | |
| | | 0.41 | | scin |

A.H.Wapstra, N.F.Verster, M.Boelhouwer, Physica 19, 138 (1953).

**$Cs^{128}$** 55 73

| | | | | | |
|---|---|---|---|---|---|
| $\tau$ | | $3.5^m$ | | d $2.4^d$ Ba | |
| $\beta^+$ | | 1.1±0.7 | | chem | a/$\gamma$ |
| | | 3.1 | | | s |
| $\gamma$ | 100† | 0.135 | | | scin |
| | | 0.29 | | | |
| | 30† | 0.455 | | | |
| | w | 0.97 | | | |

(~1.1$\beta$) ($\gamma$) $\gamma\gamma$ No (3.1$\beta$) ($\gamma$)
$\gamma$'s could belong to $Ba^{128}$

R.W.Fink, E.O Wiig, Phys. Rev. 91, 194 (1953).

**$Cs^{128}$** 55 73

| | | | | | |
|---|---|---|---|---|---|
| $\tau$ | | $3.9^m$ | | I(56-Mev $\alpha$) | |
| $\gamma$ | | ~0.46 | | | scin |
| | | 1.5 | | | |

(K x ray)/$\beta^+$ = 0.4

A.H. Wapstra, N.F.Verster, M.Boelhouwer, Physica 19, 138 (1953).

$\tau$ $3.8^m$ d $2.4^d$Ba chem
$\beta^+$ observed with $2.4^d$Ba belongs to this daughter

M.Lindner, R.N.Osborne, Phys. Rev. 88, 1422(1952).

**$Cs^{129}$** 55 74

| | | | | |
|---|---|---|---|---|
| $\gamma$ | 95† | 0.385 | I(56-Mev $\alpha$) | |
| | 5† | 0.560 | | scin |

0.040 $\gamma$ not observed

A.H. Wapstra, N.F.Verster, M.Boelhouwer, Physica 19, 138 (1953).

**$Cs^{132}$** 55 77

| | | | |
|---|---|---|---|
| $\gamma$ | 0.69 | Cs(26-Mev d) | |
| | | | scin |

A.H. Wapstra, N.F.Verster, M.Boelhouwer, Physica 19, 138 (1953).

**$Cs^{134}$** 55 79 — $2.3^y$

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $\beta^-$ | 10% | ~0.08 | | Cs(pile n) | | | |
| | 3% | ~0.21 | | | | | $s\pi\downarrow 2$ |
| | 6% | 0.410 | | | | | |
| | 81% | 0.657 | | | | | |
| | | 0.202* | | 0.797 | | 7.3 | |
| | | 0.475 | ~5 | 0.803* | | | |
| | | 0.563 | ~10 | 1.039 | | ~10 | |
| | | 0.570* | | 1.168 | | ~10 | |
| | | 0.605 | 6.4 | 1.368 | | ~10 | |
| | | 0.663* | | | | s ce$^-$, pe$^-$ | |

* $ce_K^-$ only observed

J.M.Cork, J.M.LeBlanc, W.H.Nester, M.K.Brice, Phys. Rev. 89, 907A; 90, 444 (1953).

| | | | | | | |
|---|---|---|---|---|---|---|
| $\beta^-$ | 22% | 0.085* | | | Cs(slow n); | s |
| | 0% | 0.28* | | | | |
| | 9% | 0.42* | | | | |
| | 65% | 0.65* | | | | |
| $\gamma$ | 137$^+$ | (~0.58) | $3^+$ | 1.15 | | s pe$^-$ |
| | 100$^+$ | 0.788 | $3^+$ | 1.35 | | |
| | ~2$^+$ | ~1.0 | | | | |

K.Gromov, B.Dzhelepov, Doklady Akad. Nauk SSSR 85, 299(1952). *N.Anton'eva et al., Ibid.

| | | | | |
|---|---|---|---|---|
| $\gamma$ | 0.602 | K/LM = 6.6 | s ce$^-$ | |
| | 0.799 | K/LM = 7.8 | | |

R.E.Maerker, R.D.Birkhoff, Phys. Rev. 89, 1159 (1953).

$\gamma\gamma(\theta)$, $\gamma\gamma$ polarization-direction scin
I = 4+, 2+, 0+

R.M.Kloepper, E.S.Lennox, M.L.Wiedenbeck, Phys. Rev. 88, 595(1952).

$\gamma\gamma$ polarization correlation observed
Consistent with 5±, 4+, 2+, 0+

B.L.Robinson, L.Madansky, Phys. Rev. 88, 1065 (1952).

**$Cs^{135}_{55\ 80}$**

$\beta^-$ **0.210** $\Delta I = 2$, no shape s

L.Lidofsky, E.Alperovitch, C.S.Wu, Phys. Rev. 90, 387A(1953); verbal report.

**$Cs^{137}_{55\ 82}$**

$\tau$ **33$^y$** U(n,f) chem ms
Calc. from $Cs^{137}/Cs^{133}$ ratios measured between 4.2 and 5.4 years after fission

D.R.Wiles, B.W.Smith, R.Horsley, H.G.Thode, Can. J. Phys. 31, 419(1953).

$\beta^-$ **0.512** $\Delta I = 2$, yes shape sl
**1.20** $\Delta I = 2$, no

C.D.Broyles, D.A.Thomas, S.K.Haynes, Phys. Rev. 89, 715(1953).

$\gamma$ **0.663** K/LM = 4.52 s ce$^-$

R.E.Maerker, R.D.Birkhoff, Phys. Rev. 89, 1159 (1953).

$\gamma$ **0.6614** K/LM = 4.6 s

G.A.Graves, L.W.Langer, R.D.Moffat, Phys. Rev. 88, 169A and 344(1952).

$\gamma$ **0.66165** s $\pi/2$ ce$^-$ pe$^-$
$\pm 0.00015$

G.Lindström, K.Siegbahn, A.H.Wapstra, Proc. Phys. Soc. 66B, 94(1953).

$\gamma$ **0.66160** cryst
$\pm 0.00014$

D.E.Muller, H.C.Hoyt, D.J.Klein, J.W.M.DuMond, Phys. Rev. 88, 775(1952).

**$Cs^{138}_{55\ 83}$**

$\tau$ **32$^m$** U(n,f) chem
$\beta^-$ **3.40** F-K plot not linear sl
$\gamma$ 33† **0.463** sl ce, scin
43† **0.98** scin
100† **1.44** scin
($\sim 3\beta^- \times 1.44\gamma$ ?)
(1.44$\gamma$)(0.46$\gamma$ ?) (1.44$\gamma$)(0.98$\gamma$ ?)

L.W.Langer, R.B.Duffield, C.W.Stanley, Phys. Rev. 89, 907A(1953).

**$Ba^{127}_{56\ 71}$**

$\tau$ **12$^m$** p 5.5$^h$Cs, Cs(190-Mev d)

M.Lindner, R.N.Osborne, Phys. Rev. 88, 1422(1952)A

**$Ba^{128}_{56\ 72}$**

$\tau$ **2.4$^d$** Cs(240-Mev p)
$\epsilon$ 100% p 3.5$^m$ Cs chem
See $Cs^{128}$ for possible $\gamma$'s

R.W.Fink, E.O Wiig, Phys. Rev. 91, 194 (1953).

$\epsilon$ $\sim$100% Cs(190-Mev d) chem
$\beta^+$ in 3.8$^m$Cs daughter

M.Lindner, R.N.Osborne, Phys. Rev. 88, 1422(1952)

**$Ba^{129}_{56\ 73}$**

$\beta^+$ **1.6** Ca(80-Mev p) s chem

R.W.Fink, E.O.Wiig, Phys. Rev. 91, 194 (1953).

**$Ba^{131}_{56\ 75}$**

$\tau$ **11.8$^d$** $Ba^{130}$ (pile n)

| $\gamma$ | | K/L | | K/L |
|---|---|---|---|---|
| | 0.055 | $\leq 1$ | 0.249 | $\geq 6$ |
| | 0.079 | 10 | 0.374 | 6.0 |
| | 0.092 | | 0.489 | |
| | 0.124 | 3.6 | 0.498 | 7.7 |
| | 0.133 | 5.8 | 0.585 | |
| | 0.216 | 9 | 0.620 | |
| | 0.239 | $\geq 6$ | | s ce$^-$, pe$^-$ |

No 0.82 or 1.2 $\gamma$ scin

J.M.Cork, J.M.LeBlanc, W.H.Nester, M.K.Brice, Phys. Rev. 91, 76; 91, 497A (1953).

$\gamma$ Ba(pile n); s

| | | $\alpha_K$ | K/LM | | |
|---|---|---|---|---|---|
| | 0.043 | | | | ce$^-$ |
| | 0.065 | | $\sim 3.5$ | | |
| | 0.108 | | $\sim 7$ | | |
| | 0.122 | | 6.0 | | |
| 10† | 0.214 | $\sim 0.18$ | 2.8 | E2 | ce$^-$,pe$^-$ |
| 4† | 0.241 | | | | |
| 7† | 0.370 | $\sim 0.010$ | | E1 | |
| 100† | 0.494 | $\sim 0.0045$ | 2.5 | E2 | |

M.W.Elliott, L.S.Chen, J.R.Haskins, J.D.Kurbatov, Phys. Rev. 88, 263(1952).

| $\gamma$ | | | | |
|---|---|---|---|---|
| w | $\sim 0.10$ | Ba(pile n) | | |
| 55† | 0.122 | chem | scin | |
| 45† | $\sim 0.220$ | | | |
| 25† | 0.370 | | | |
| 100† | 0.500 | | | |
| 8† | 0.620 | | | |
| 3† | 0.90* | | | |
| 3† | 1.02* | | | |
| x 145† | K x ray | | | |

(0.12$\gamma$) (0.50$\gamma$) *Possible impurities

W. Payne, M.Goodrich, Phys. Rev. 91, 497A (1953); verbal report.

**$Ba^{133}_{56\ 77}$**
**$39^h$**

$\gamma$ (0.012) $\tau < 0.02^{\mu s}$

M.Langevin, Compt. rend 236, 689(1953).

$\gamma$ 0.276 Ba(pile n)

J.M. Cork, J.M.LeBlanc, W.H.Nester, M.K.Brice, Phys. Rev. 91, 76 (1953).

**$Ba^{135}_{56\ 79}$**
**$29^h$**

$\gamma$ 0.268 Ba(pile n)

J.M. Cork, J.M.LeBlanc, W.H.Nester, M.K.Brice, Phys. Rev. 91, 76 (1953).

**$Ba^{138}_{56\ 82}$**

$\tau_{\beta\beta}$ **$> 10^{15y}$** ppl
Assuming decay energy $\geq 2$ Mev

J.H.Fremlin, M.C.Walters, Proc. Phys. Soc. 65A, 911(1952).

**$Ba^{140}_{56\ 84}$**

$\gamma$ **0.540** K/LM$\sim$6 s ce$^-$

R.E.Maerker, R.D.Birkhoff, Phys. Rev. 89, 1159 (1953).

La No neutron resonances $E_n$=0.1 to 30 ev

V.L. Sailor, H.H.Landon, H.L.Foote, Phys. Rev. 91 450A (1953).

**$La^{135}_{57\ 78}$**

| | | | | |
|---|---|---|---|---|
| $\gamma$ | 6† | 0.49 | Ba(26-Mev d) | |
| | 1† | 0.66 | chem | scin |
| x | 300† | K x ray | | |

A.H.Wapstra, Physica 19, 671 (1953).

**$La^{140}_{57\ 83}$**

| | | | |
|---|---|---|---|
| $\tau$ | | $40.2^h$ | La(pile n) |

R.M.Bartholomew, F.Brown, R.C.Hawkins, W.F.Merritt, L.Yaffe, Can. J. Chem. 31, 120(1953).

| | | | |
|---|---|---|---|
| $\gamma$ | | 0.3286 ± 0.0003 | s $\pi\sqrt{2}$ $pe^-$ |
| | | 0.4867 ± 0.0004 | |
| | | 0.8151 ± 0.0007 | |
| | | 1.596 ± 0.002 | |

A.Hedgran, D.Lind, Arkiv Fysik 5, 177(1952).

| | | | |
|---|---|---|---|
| $\gamma$ | | 0.488 | K/LM = 3.7 s $ce^-$ |

R.E.Maerker, R.D.Birkhoff, Phys. Rev. 89, 1159 (1953).

| | | | |
|---|---|---|---|
| Capture $\gamma$ | | La(n,$\gamma$) | scin |
| | | 4.5 | |

B.Hamermesh, V.Hummel, Phys. Rev. 88, 916(1952).

**$La^{142}_{57\ 85}$**

| | | | | |
|---|---|---|---|---|
| $\beta^-$ | | >2.5 | U(n,f) | chem; a |
| $\gamma$ | 90† | 0.63 | | scin |
| | 10† | 0.87 | | |

(<2.5$\beta^-$) ($\gamma$)

A.V. Bosch, Physica 19, 374 (1953).

**Ce** No neutron resonances $E_n$=0.1 to 30 ev

V.L.Sailor, H.H.Landon, H.L.Foote, Phys. Rev. 91, 450A (1953).

No fission product Ce with $6^m < \tau < 13.9^m$ chem

A.A.Caretto, Jr., S.Katcoff, Phys. Rev. 89, 1267 (1953).

**$Ce^{141}_{58\ 83}$**

| | | | |
|---|---|---|---|
| $\gamma$ | (0.145) | $\tau < 2 \times 10^{-9}$ s | $\beta\gamma$ |

T.C.Engelder, Phys. Rev. 90, 259(1953).

**$Ce^{143}_{58\ 85}$**

| | | | | |
|---|---|---|---|---|
| $\beta^-$ | 100† | 0.71 | $Ce^{142}$(pile n,$\gamma$), | |
| | 133† | 1.090 | U(pile n,f) | chem |
| | 100† | 1.390 | | |
| $\gamma$ | ~20† | 0.126 | | sl $pe^-$, scin |
| | | ~0.160 | | |
| | 100† | 0.290 | | |
| | ~20† | 0.356 | | |
| | ~25† | 0.660 | | |
| | | 0.72 | | |

Unresolved lower energy $\beta$
(0.126$\gamma$) (0.160$\gamma$)

W.M.Burgus, Phys. Rev. 88, 1129(1952).

**$Ce^{145}_{58\ 87}$** No $1.8^h$Ce activity U(n,f) chem
Previously reported activity due to $2.0^n$Nd impurity?

A.A.Caretto, Jr., S.Katcoff, Phys. Rev. 89, 1267 (1953).

**$Ce^{146}_{58\ 88}$**

| | | | | |
|---|---|---|---|---|
| $\tau$ | | $13.9^m$ | p $24.4^m$Pr | U(n,f) chem |
| $\beta^-$ | | ~0.9 | | a |
| $\gamma$ | | ~0.2 | | a |

A.A.Caretto, Jr., S.Katcoff, Phys. Rev. 89, 1267 (1953).

**Pr** No neutron resonances $E_n$=0.1 to 30 ev

V.L.Sailor, H.H.Landon, H.L.Foote, Phys. Rev. 91, 450A (1953).

**$Pr^{140}_{59\ 81}$**

| | | | |
|---|---|---|---|
| $\beta$+ | | 2.4 | Pr(≲70-Mev $\gamma$) scin |

F.I.Boley, Iowa State Coll. J. Sci. 27,129(1953).

**$Pr^{141}_{59\ 82}$**

| | | | |
|---|---|---|---|
| I | | 5/2 | para |

C.F.Davis et al, Atti accad. nazl. Lincei, Classe sci. fis. mat. e nat. 11, 77(1951). NSA 6-3679.

| | | | |
|---|---|---|---|
| $\mu$ | | +3.9 | S |

Calculated from data of White, Phys. Rev. 34, 1397(1929)

P.Brix, Phys. Rev. 89, 1245(1953).

| | | | |
|---|---|---|---|
| $\mu$ | | +3.8 | M |
| Q | | -0.054 | |

H.Lew, Phys. Rev. 91, 619; 89, 530 (1953).

**$Pr^{144}_{59\ 85}$**

| | | | |
|---|---|---|---|
| $\gamma$ | (0.695) | $\tau < 2 \times 10^{-9}$ s | $\beta\gamma$ |

T.C.Engelder, Phys. Rev. 90, 259(1953).

$\gamma\gamma$ polarization - direction scin
I = 1-,2+,0+

D.M.Roberts, Phys. Rev. 91, 497A (1953); verbal report.

**$Pr^{145}_{59\ 86}$** No $4.5^h$Pr activity U(n,f) chem
Previously reported activity due to $3.7^h$La impurity?

A.A.Caretto, Jr., S.Katcoff, Phys. Rev. 89, 1267 (1953).

**$Pr^{146}_{59\ 87}$**

| | | | | |
|---|---|---|---|---|
| $\tau$ | | $24.4^m$ | d $13.9^m$Ce | U(n,f) chem |
| $\beta^-$ | | 3.8 | | a |

A.A.Caretto, Jr., S.Katcoff, Phys. Rev. 89, 1267 (1953).

**Nd** Relative abundances

| | | | | |
|---|---|---|---|---|
| A | 142 | 143 | 144 | 145 |
| % | 27.09 | 12.14 | 23.83 | 8.29 |
| A | 146 | 148 | 150 | |
| % | 17.26 | 5.74 | 5.63 | |

W.H.Walker, H.G.Thode, Phys. Rev. 90,447 (1953).

**$Nd^{147}_{60\ 87}$**

| | | | |
|---|---|---|---|
| $\gamma$ | (0.092) | $\tau = 2.44 \times 10^{-9}$ s | |
| | | $\alpha_k$ = 1.8 | K:L:M = 29:4:1 |

R.L.Graham, R.E.Bell, Can. J. Phys. 31, 377(1953).

**$Pm^{142}$ ?** 61 81

$\tau$ 260$^d$ $Nd^{142}$ (7-Mev p)

J.K.Long, M.L.Pool, D.N.Kundu, Phys. Rev. 88, 171A(1952).

**$Pm^{143}$ ?** 61 82

$\tau$ 320$^d$ $Nd^{143}$ (7-Mev p)

J.K.Long, M.L.Pool, D.N.Kundu, Phys. Rev. 88, 171A(1952).

**$Pm^{145}$ ?** 61 84

$\tau$ 16$^d$ $Nd^{145}$ (7-Mev p)

$\beta^+$ 0.45

J.K.Long, M.L.Pool, D.N.Kundu, Phys. Rev. 88, 171A(1952).

**$Pm^{146}$** 61 85

$\tau$ ~2$^y$ $Nd^{146}$ (7-Mev p)

$\beta^-$ 0.75

J.K.Long, M.L.Pool, D.N.Kundu, Phys. Rev. 88, 171A(1952).

**Sm** Neutron resonances (ev)* $E_n$ = 0.1ev to 40ev

3.43** 19
12 ? 22
15.2

*Isotopic assignment uncertain
**Not Sm 149, 152, or 154

V.L.Sailor, H.L.Foote, Jr., H.H.Landon, Phys. Rev. 89, 904A(1953); priv. comm.

**$Sm^{147}$** 62 85

$E_\alpha$ 2.12 ± 0.03 ppl

D.Szteinsznaider, J. Phys. radium 14, 465(1953).

**$Sm^{149}$** 62 87

Neutron resonances (ev) $E_n$ = 0.1ev to 40ev

0.094
0.87
4.95

V.L.Sailor, H.L.Foote, Jr., H.H.Landon, Phys. Rev. 89, 904A(1953); priv. comm.

**$Sm^{150}$** 62 88

Capture $\gamma$'s $Sm^{149}(n,\gamma)$ s $\pi$ ce$^-$

0.337 K/L~4.4
0.440 K/L~3

C.T.Hibdon, C.O.Muehlhause, Phys. Rev. 88, 943 (1952); 87, 222A(1952).

**$Sm^{151}$** 62 89

$\beta^-$ ~0.075 Sm(th n); pc

$\gamma$ 0.019 pc

(0.019$\gamma$) ($\beta^-$) scin

H.W.Wilson, G.M.Lewis, Proc. Phys. Soc. 65A, 656 (1952).

**$Sm^{152}$** 62 90

Neutron resonance (ev) $E_n$ = 0.1ev to 40ev

8.20

V.L.Sailor, H.L.Foote, Jr., H.H.Landon, Phys. Rev. 89, 904A(1953); priv. comm.

**$Sm^{153}$** 62 91

| | | |
|---|---|---|
| $\beta^-$ | 9% | 0.255 s $\pi$ |
| | <2% | 0.62? |
| | 70% | 0.685 |
| | 21% | 0.795 |
| $\gamma$ | | 0.0691 s $\pi$ ce$^-$ |
| | | 0.1027 |
| | | 0.548 |

R.Katz, M.R.Lee, Phys. Rev. 92, 848A(1953).

**Eu** Neutron resonances (ev) $E_n$=0.1 to 30 ev

| | | |
|---|---|---|
| 0.46 | 2.72 | 7.32 |
| 1.06 | 3.35 | 8.95 |
| 1.77 | 3.85 | 15.2 |
| 2.47 | 6.2 | 20 |

V.L.Sailor, H.H.Landon, H.L.Foote, Jr., Phys. Rev. 91, 450A (1953); verbal report.

**$Eu^{147}$** 63 84

$\tau$ 24$^d$ $Sm^{147}$ (6.7-Mev p)

$\gamma$ 0.12 scin

0.21 s $\pi$ ce$^-$

No $\beta^+$

R.C.Mack, J.J.Neuer, M.L.Pool, Phys. Rev. 91,497A (1953).

**$Eu^{148}$** 63 85

$\tau$ 54$^d$ $Sm^{148}$ (6.7-Mev p)

$\gamma$ 0.58 s $\pi$ ce$^-$

R.C.Mack, J.J.Neuer, M.L.Pool, Phys. Rev. 91,497A (1953).

**$Eu^{149}$** 63 86

$\tau$ 120$^d$ $Sm^{149}$ (6.7-Mev p)

$\gamma$ 0.30 scin, s $\pi$ ce$^-$

0.57

R.C.Mack, J.J.Neuer, M.L.Pool, Phys. Rev. 91,497A (1953); verbal report.

**$Eu^{150}$** 63 87

$\tau$ 13.7$^h$ $Sm^{150}$ (6.7-Mev p)

$\beta^-$ 1.07 s $\pi$

No $\beta^+$

F-K plot complex? but no $\gamma$, no ce$^-$

R.C.Mack, J.J.Neuer, M.L.Pool, Phys. Rev. 91,903; 91, 497A (1953).

**$Eu^{152}$** 63 89 9.3$^y$

$\tau_2$ 12.4$^y$ ± 0.4 Eu(pile n)

Counted for 1.1 years with $\beta$ electroscope

E.E.Lockett, R.H.Thomas, Nucleonics 11, No. 3, 14(1953).

$\tau_2$ 15.6$^y$ ± 1.5 Eu(pile n)

Counted for 200 days with ic

J.Kastner, Can. J. Phys. 31, 169(1953).

**$Eu^{152,154}$** 63

$\gamma$ 1.40 s $\pi$ pe$^-$

L.Y.Shavtvalov, Zhur. Eksptl' i Teoret. Fiz. 23, 611(1952).

**$Eu^{155}$** 63 92

$\beta^-$ ~0.150 Sm(th n,$\gamma\beta^-$); pc

~0.250

$\gamma$ 0.015 pc

(~0.150$\beta^-$) ($\gamma$) ($\beta^-$) (0.015$\gamma$)

H.W.Wilson, G.M.Lewis, Proc. Phys. Soc. 65A, 656 (1952).

**Gd** Neutron resonances (ev) $E_n$= 0.7 to 1000 ev

| | | |
|---|---|---|
| 1.93 | 14.4 | 49 |
| 2.58* | 16.6 | 81 |
| 2.85* | 20.6* | 109 |
| 6.26 | 22.2* | 355 |
| 7.74 | 29.8 | 740 |
| 11.6 | 33.2 | |

$E_o$=2.58 $\sigma_o$=1600 $\Gamma$ = 0.07 ev

* Most prominent

R.R.Palmer, L.M.Bollinger, Phys. Rev. 91,450A (1953); verbal report.

**$Gd^{148}$ ?** (64, 84)

$\tau$ > $35^{y}$ $Sm^{147}$(32-Mev d)Eu(32-Mev p);
$\alpha$ >25%* 3.2 ion chem yield; ic
No $\gamma^{h}$ activity found Sm(30-Mev $\alpha$) ion chem
($7.5^{h}$At from Bi impurity?)
*Assuming $\sigma$(36-Mev $\alpha$,3n) = 1

J.O.Rasmussen, Jr., S.G.Thompson, A.Ghiorso, Phys. Rev. 89, 33(1953).

**$Gd^{149}$** (64, 84)

$\epsilon$ $Sm^{147}$(31-Mev $\alpha$) not Sm(19-Mev d),
$\alpha$ ~0.0007% 3.0 ion chem; ic

J.O.Rasmussen, Jr., S.G.Thompson, A.Ghiorso, Phys. Rev. 89, 33(1953).

**$Gd^{150}$** (64, 86)

$\tau_{\alpha}$ $>10^{5}y$ ic cc
No $\alpha$ daughter from $13.7^{h}$ Eu found

R.C.Mack, J.J.Neuer, M.L.Pool, Phys. Rev. 91,903 (1953).

**$Gd^{150}$ ?** (64, 86)

$\alpha$ 2.7 Eu(19-Mev d) chem; ic

J.O.Rasmussen, Jr., S.G.Thompson, A.Ghiorso, Phys. Rev. 89, 33(1953).

**$Gd^{153}$** (64, 89)

$\gamma$ 0.1037 K/L = 5 $s\pi$ $ce^{-}$
No other $\gamma$ Gd(pile n)

J.M.Cork, J.W.LeBlanc, W.H.Nester, F.B.Stumpf, Phys. Rev. 88, 685(1952).

**$Gd^{156}$, $Gd^{158}$** (64)

Capture $\gamma$'s Gd(n,$\gamma$) $s\pi$ $ce^{-}$
0.079 K/L~0.3 L/M~2.5
0.088
0.180

C.T.Hibdon, C.O.Muehlhause, Phys. Rev. 88, 943 (1952); 87, 222A(1952).

**$Tb^{149}$** (65, 84)

$\tau$ $4.1^{h}$ Eu(60-Mev $\alpha$)
$\epsilon$ ? Gd(31-Mev p); ion chem
$\alpha$ 3.95
No $\beta^{+}$

J.O.Rasmussen, Jr., S.G.Thompson, A.Ghiorso, Phys. Rev. 89, 33(1953).

**$Tb^{151}$ ?** (65, 86)

$\tau$ $19^{h}$ Gd(100-Mev p) Eu(45-Mev $\alpha$)
$\alpha$ >0.0004%* 3.4 ion chem; ic

J.O.Rasmussen, Jr., S.G.Thompson, A.Ghiorso, Phys. Rev. 89, 33(1953); *M.A.Rollier, J.O.Rasmussen, ibid.

**$Tb^{157}$** (65, 92)

$\tau$ $>100^{y}$ or $<30^{m}$
Not observed from Tb(24-Mev p) or as d of $8.2^{h}$ Dy

T.H.Handley, E.L.Olson, Phys. Rev. 90,500 (1953).

**$Tb^{161}$** (65, 96)

$\tau$ $6.8^{d}$ Gd(pile n); $s\pi$ $ce^{-}$
$\gamma$ 0.049 L/M = 3.7
No other $\gamma$

J.M.Cork, J.W.LeBlanc, W.H.Nester, F.B.Stumpf, Phys. Rev. 88, 685(1952).

**Dy** Neutron resonances (ev) $E_n$ = 0.1 to 30 ev

| | | |
|---|---|---|
| 1.72 | 5.47 | 16.8 |
| 2.72 | 7.8 | 19.5 |
| 3.7 | 10.6 | 29.5 |
| 4.3 | 13.5 | 38.5 |

V.L.Sailor, H.H.Landon, H.L.Foote, Jr., Phys. Rev. 91, 450A (1953); verbal report.

**$Dy^{\geq 149}_{\leq 153}$** (66)

$\tau$ $19^{m}$ Tb(100-Mev p)
$\alpha$ 4.1 not Eu(120-Mev $\alpha$); ic

$\tau$ $2.3^{h}$ Tb(100-Mev p); ion chem
$\alpha$ 3.6 Nd(~100-Mev $C^{12}$); ic

$\tau$ $7^{m}$ Tb(100-Mev p)
$\alpha$ 4.2 Nd(~100-Mev $C^{12}$); ic
not Eu(120-Mev $\alpha$)

J.O.Rasmussen, Jr., S.G.Thompson, A.Ghiorso, Phys. Rev. 89, 33(1953).

**$Dy^{157}$** (66, 91)

$\tau$ $8.2^{h}$ Tb(19-Mev p)
$\gamma$ 0.325 ion chem, rel $\sigma$ scin
No $\beta^{+}$ or $e^{-}$ observed

T.H. Handley, E.L.Olson, Phys. Rev. 90,500(1953).

**$Dy^{165}$** (66, 99) $1.3^{m}$

$\gamma$ 0.102 Dy(pile n); scin

J.M.Kahn, ORNL-1089(1951).

$\gamma$ 0.1080 Dy(pile n)
K : $L_{II}$ : $L_{III}$ : M: N
3 : 10 : 10 : 5: 1.5
0.155? scin, $s\pi$ $ce^{-}$
0.361
0.515
(~1$\beta$) (0.36$\gamma$,0.52$\gamma$) No (0.36$\gamma$) (0.52$\gamma$)

W.C. Jordan, J.M.Cork, S.B.Burson, Phys. Rev. 91, 497A (1953); verbal report.

$2.4^{h}$ $\gamma$ 0.0944 Dy(pile n)
K : L : M
80 : 7.8 : 1.5
0.279 K/L >5 $s\pi$ $ce^{-}$
0.361 K/L >5
0.634
0.71
1.02
(~0.3$\beta$) (0.28$\gamma$,0.36$\gamma$,0.63$\gamma$)
(~1.3$\beta$) (0.094$\gamma$)
(0.28$\gamma$) (0.71$\gamma$) (0.36$\gamma$) (0.63$\gamma$) No other $\gamma\gamma$

W.C. Jordan, J.M.Cork, S.B.Burson, Phys. Rev. 91, 497A (1953).

**$Dy^{165}$** (66, 99)

Capture $\gamma$'s Dy(n,$\gamma$) $s\pi$ $ce^{-}$
0.082
0.106
0.189

C.T.Hibdon, C.O.Muehlhause, Phys. Rev. 88, 943 (1952); 87, 222A(1952).

**Ho** Neutron resonances (ev) $E_n$ = 0.1 to 30 ev

| | | | |
|---|---|---|---|
| 3.96 | | | cryst s |
| 12.8 | | | |

H.H.Landon, V.L.Sailor, H.L.Foote, Jr., Phys. Rev. 90, 362A(1953).

**Ho?**

| | | | |
|---|---|---|---|
| $\tau$ | ~4$^m$ | | Dy(200-Mev p) |
| $\alpha$ | 4.2 | | Sm(100-Mev $C^{12}$)? ic |

No Ho $\alpha$ activity observed with $\tau > 1^h$
Er(200-Mev p) Yb(250-Mev p); ion chem

J.O.Rasmussen, Jr., S.G.Thompson, A.Ghiorso, Phys. Rev. 89, 33(1953).

**Er** Neutron resonances (ev) $E_n$ = 0.1 to 30 ev

| | | | |
|---|---|---|---|
| 0.51 | 9.55 | 21.2 | cryst s |
| 6.10 | 16.0 | 27.5 | |

H.H.Landon, V.L.Sailor, H.L.Foote, Jr., Phys. Rev. 90, 362A(1953).

No Er $\alpha$ activity observed with $\tau > 1^h$
Er(200-Mev p) Yb(250-Mev p); ion chem

J.O.Rasmussen, Jr., S.G.Thompson, A.Ghiorso, Phys. Rev. 89, 33(1953).

**$Er^{167}_{68\ 99}$**

| | | | |
|---|---|---|---|
| \|Q\| | 10.2 | | para |

G.S.Bogle, H.J.Duffus, H.E.D.Scovil, Proc. Phys. Soc. 65A, 760(1952).

**Tm** Neutron resonances (ev) $E_n$ = 0.1 to 30 ev

| | | | |
|---|---|---|---|
| 3.96 | | | cryst s |
| 15.0 | | | |
| 18.0 | | | |

H.H.Landon, V.L.Sailor, H.L.Foote, Jr., Phys. Rev. 90, 362A(1953).

No Tm $\alpha$ activity observed with $\tau > 1^h$
Er(200-Mev p) Yb(250-Mev p); ion chem

J.O.Rasmussen, Jr., S.G.Thompson, A.Ghiorso, Phys. Rev. 89, 33(1953).

**$Tm^{170}_{69\ 101}$**

| | | | | |
|---|---|---|---|---|
| $\beta^-$ | 24% | 0.884 | Tm(pile n); sl $\beta\gamma$ | |
| | 76% | 0.968 | | sl |
| $\gamma$ | | 0.0841 | $\tau = 1.57 \times 10^{-9}$ s | |

$\alpha_K$ = 1.6 $\alpha_L$ = 4.1 $\alpha_M$ = 1.2 E2
$\epsilon_K$ < 0.3% ($\beta$) (0.084$\gamma$)
No other $\gamma$'s (< 0.02%)
F-K plots of both $\beta$'s linear

R.L.Graham, J.L.Wolfson, R.E.Bell, Can. J. Phys. 30, 459(1952).

**Yb** Neutron resonances (ev) $E_n$ = 0.1 ev to 40 ev

| | | |
|---|---|---|
| 0.597 | 13.3 | |
| 4.55 | 18.2 | |
| 8.09 | 30 | |

V.L.Sailor, H.L.Foote, Jr., H.H.Landon, Phys. Rev. 89, 904A(1953).

**$Yb^{?}_{70\ 6^s}$**

| | | |
|---|---|---|
| $\gamma$ | 0.21 | Yb(pile n); scin |
| | 0.10 (Dy impurity ?) | |

J.H.Kahn, ORNL-1089(1951).

**Lu** Neutron resonances (ev) $E_n$ = 0.1 to 30 ev

| | | | |
|---|---|---|---|
| 1.57 | 5.3 | 14.4 | cryst s |
| 2.62 | 11.4 | 24.0 | |
| 4.80 | | | |

H.H.Landon, V.L.Sailor, H.L.Foote, Jr., Phys. Rev. 90, 362A(1953).

**$Lu^{176}_{71\ 105}$** 2.4x$10^{10y}$

| | | | |
|---|---|---|---|
| $\tau_{\beta^-}$ | | 2.0 x $10^{10y}$ | 92 $\beta$'s/sec/g Lu* |
| | | | 200 $\gamma$'s/sec/g Lu |
| $\beta^-$ | | ~0.4 | a |
| $\gamma$ | 100 † | 0.20 | scin |
| | 100 † | 0.32 | |

(0.32$\gamma$) (0.20$\gamma$) (0.4$\beta$) ($\gamma$)
No 0.52$\gamma$ (< 10%) 0.090$\gamma$ not observed
x ray/disintegration ~0.35
accounted for by $\gamma$ conversion

J.R.Arnold, T.Sugihara, Phys. Rev. 90, 332(1953); *A.D.Suttle, Jr., ibid.

**$Lu^{176}_{71\ 105}$**

| | | |
|---|---|---|
| Neutron resonance (ev) | | cryst s |
| 0.142 | | |

H.H.Landon, V.L.Sailor, H.L.Foote, Jr., Phys. Rev. 90, 362A(1953); verbal report.

**$Lu^{177}_{71\ 106}$**

(0.206$\gamma$) (0.112$\gamma$) b = - 0.20
I = 5/2, 7/2, 3/2 (E)1, (E)2

T.Wiedling, Arkiv Fysik 6, 39(1953).

**Hf** Relative abundances $HfF_4$; ms

| | | | |
|---|---|---|---|
| A | 174 | 176 | 177 |
| % | 0.199 | 5.23 | 18.55 |
| A | 178 | 179 | 180 |
| % | 27.23 | 13.73 | 35.07 |

J.H.Reynolds, Phys. Rev. 90, 1047 (1953).

Neutron resonances (ev) $E_n$ = 0 to 100 ev
One each in $Hf^{178}$, $Hf^{180}$, ~25 in $Hf^{177}$ or $Hf^{179}$
None in $Hf^{174}$ or $Hf^{176}$

D.J.Hughes, W.Y.Kato, J.S.Levin, Phys. Rev. 92, 1094 (1953).

**$Hf^{179}_{72\ 107}$** 19$^s$

| | | |
|---|---|---|
| $\gamma$ | 0.22 | Hf(pile n); scin |

J.H.Kahn, ORNL-1089(1951).

**$Hf^{181}_{72\ 109}$**

| | | |
|---|---|---|
| $\gamma$ | 0.133 | E2 |
| | $L_I : L_{II} : L_{III}$ = 0.20: 1.22: 1.00 | |

J.B.Swan, R.D.Hill, Phys. Rev. 91,424(1953).

| | | | |
|---|---|---|---|
| $\gamma$ | (0.133) | $\tau$ = 17.2$^{\mu s}$ | $\beta ce^-$ |

R.Ballini, Ann. Phys. 8, 441 (1953).

Level (0.48) $\tau = 1.04 \times 10^{-8}$ s $(ce^-)(\gamma)$

T.C.Engelder, Phys. Rev. 90, 259(1953).

Level (0.48) $\tau = 1.06 \times 10^{-8}$ s $\gamma\gamma$

H.deWaard, Physica 18, 1151 (1952).

**$Ta^{181}$** 73 108

| | | |
|---|---|---|
| $\mu$ | 1.9 | S |
| q | +5.9 | |

B.M.Brown, D.M.Tamboulian, Phys. Rev. 88, 1158 (1952).

| | | | |
|---|---|---|---|
| Levels | Ta(p,p'$\gamma$) | $E_p$ = 1.0 to 2.2 | |
| $\gamma$ | 0.137 ± 0.005 | | scin |
| | 0.300 ± 0.010 | | |

$\sigma$ for $E_p$ = 1.0–2.2 agrees with collective model prediction for E2 coulomb excitation

T.Huus, Č.Zupančič, Kgl. Danskab. Selskab, Mat-fys. Medd. 28, No. 1 (1953).

| | | | |
|---|---|---|---|
| $\gamma$'s | Ta(p,p'$\gamma$) | $E_p$ = 1.42 | |
| | 0.138 | | scin |
| | 0.35? | | |
| | 0.50? | | |

C.L.McClelland, C.Goodman, Phys. Rev. 91, 760 (1953).

| | | | |
|---|---|---|---|
| $\gamma$ | Ta($\gamma,\gamma'$) | $E_\gamma \leqslant 6.5$ | |
| 0.130 | $\tau = 16 \pm 3^{\mu s}$ | | scin |

h.N.Brown, R.A.Becker, Phys. Rev. 90,328(1953).

**$Ta^{182}$** 73 109 $117^d$

| | | | | |
|---|---|---|---|---|
| $\gamma$ | 0.9† | 0.065714 | 1.9† | 0.17936 |
| | 10.0† | 0.067736 | 0.9† | 0.19830 |
| | 0.6† | 0.084667 | 4.5† | 0.22205 |
| | 4.6† | 0.10009 | 2.4† | 0.22927 |
| | 0.9† | 0.11366 | 2.7† | 0.26409 |
| | 0.2† | 0.11640 | 35.2† | 1.121 |
| | 4.3† | 0.15241 | 15.7† | 1.188 |
| | 1.4† | 0.15637 | 33.4† | 1.223 |

No Hf x ray Ta(pile n), cryst

Possible decay schemes enumerated

D.E.Muller, H.C.Hoyt, D.J.Klein, J.W.M.DuMond, Phys. Rev. 88, 775(1952).

| | | | | |
|---|---|---|---|---|
| $\gamma$ | 0.22 | 0.29 | 1.23 | sl pe$^-$ |
| | 0.25 | 0.31 | 1.24 | |
| | 0.27 | 1.01 | | |
| | 0.28 | 1.13 | | |

R.W.Pearce, K.C.Mann, Can. J. Phys. 31, 592 (1953).

**$Ta^{183}$** 73 110

| | | |
|---|---|---|
| $\tau$ | ~6$^d$ | $Ta^{181}(n,\gamma)Ta^{182}(n,\gamma)Ta^{183}$ |
| $\gamma$ | 0.246 | sm ce$^-$ |

Numerous other weak ce$^-$

J.W.Mihelich, Phys. Rev. 91, 427 (1953).

**W**

| | | | |
|---|---|---|---|
| | W(p,p) | $E_p$ = 1.8 | |
| $\gamma$ | ~0.115 | | scin |

Broad peak presumed to be 0.102 $\gamma$ of $W^{180}$ and 0.123 $\gamma$ of $W^{186}$ produced by E2 coulomb excitation

T.Huus, Č.Zupančič, Kgl. Danskab. Selskab, Mat.-fys. Medd. 28, No. 1 (1953).

**$W^{178}$?** 74 104

| | | |
|---|---|---|
| $\tau$(atomic) | $2.2 \times 10^{17}$y | ppl |
| $\alpha$ | 3.2 | |

$\tau$(calc) ~ $6 \times 10^{8}$y, ∴ abundance of isotope responsible ~ $2.5 \times 10^{-9}$. Suggest $W^{178}$

W.Porschen, W.Riezler, Naturf. 8a, 502(1953).

**$W^{185}$** 74 111

| | | |
|---|---|---|
| No 0.134 $\gamma$ | W(pile n) | |
| | scin, sm ce$^-$ | |

N. Lazar, R.J.D.Moffat, L.M.Langer, Phys. Rev. 91, 498A (1953).

**$W^{186}$** 74 112

| | | |
|---|---|---|
| $\tau_{\beta\beta}$ | $>6 \times 10^{15}$y | ppl |

Assuming decay energy ⩾ 2 Mev

J.H.Fremlin, M.C.Walters, Proc. Phys. Soc. 65A, 911(1952).

**$W^{187}$** 74 113

| | | |
|---|---|---|
| $\tau$ | $23.85^h$ | W(slow n) |

G.G.Eichholz, Phys. Rev. 89, 525(1953).

| | | | |
|---|---|---|---|
| $\tau$ | | $24.0^h$ | $W^{186}$(pile n,$\gamma$) |
| $\beta^-$ * | 80% | 0.622 | $8\pi\sqrt{2}$ |
| | 20% | 1.304 | |

| $\gamma$ | K/L | $\gamma$ | K/L |
|---|---|---|---|
| 0.072 | | 0.513 | |
| 0.106 | | 0.552 ? | |
| 0.114 | | 0.619 | 4 |
| 0.134 | 5.5 | 0.626 | |
| 0.206 | | 0.686 | 5 |
| 0.239 | | 0.774 | |
| 0.246 | | 0.866 | |
| 0.480 | 4.2 | | |

$L_I / L_{III}$ ~60 for 0.134$\gamma$

J.M.Cork, M.K.Brice, W.H.Nester, J.M.LeBlanc, D.W.Martin, Phys. Rev. 89, 1291(1953); *A.E. Stoddard, ibid.

| | | | |
|---|---|---|---|
| $\gamma$ | (0.13) | $\tau < 2 \times 10^{-9}$s | $\beta\gamma$ |

T.C.Engelder, Phys. Rev. 90, 259(1953).

| | |
|---|---|
| $\gamma$ | 0.07200 cryst |
| | 0.13425 |
| | 0.4795 |
| | 0.6189 |
| | 0.6861 |

0.6189$\gamma$ not crossover

D.E.Muller, H.C.Hoyt, D.J.Klein, J.W.M.DuMond, Phys. Rev. 88. 775(1952).

| | | | | | |
|---|---|---|---|---|---|
| $\gamma$ | 0.072 | $\alpha_K$~2 | $\alpha$<2.5 | E1 | pc |
| | 0.134 | $\alpha_K$~2 | | M1 | |
| | 0.480 | | | | |
| | 0.552 | | | | |
| | 0.686 | | | E1 | |
| | 0.78 | | | | |

(0.48$\gamma$)(0.13$\gamma$) (0.55$\gamma$)(0.13$\gamma$) (0.78$\gamma$)(0.13$\gamma$)

No (0.618$\gamma$) ($\gamma$)

No 0.206$\gamma$ (< 3% of 0.134$\gamma$)

0.48$\gamma$ precedes 0.072$\gamma$

A.W.Sunyar, Phys. Rev. 90,387A(1953); verbal report

**Re**

| | | |
|---|---|---|
| Neutron resonance (ev) | | cryst s |
| 2.16 | | |

H.H.Landon, V.L.Sailor, H.L.Foote, Jr., Phys. Rev. 90, 363A(1953).

**$Re^{185}$** 75 110

I 5/2 Mic

$q(Re^{185})/q(Re^{187}) = 1.06$

A.Javan, G.Silvey, C.H.Townes, A.V.G sse, Phys. Rev. 91,222A(1953).

**$Re^{186}$** 75 111

$\beta^-$ 0.08% (~0.3)

J.E. Robinson, C.E.Whittle, P.S.Jastram, Phys. Rev. 91, 498A (1953).

$\gamma$ **0.137** $L_{II}/L_{III} = 1.24$ E2

J.B.Swan, R.D.Hill, Phys. Rev. 91, 424(1953).

$\gamma$ (0.137) $\tau = 1.8\times10^{-9}$s

C.C.McMullen, W.W.Johns, Phys. Rev. 91, 418(1953).

$(0.93\beta)(0.14\gamma)(\theta)$ b <0.0007

C.E. Whittle, J.P.Hurley, P.S.Jastram, Phys. Rev. 91, 498A (1953); verbal report.

**$Re^{187}$** 75 112

I 5/2 Mic

$q(Re^{185})/q(Re^{187}) = 1.06$

A.Javan, G.Silvey, C.H.Townes, A.V.Grosse, Phys. Rev. 91,222A(1953).

$\beta^-$ ~0.034 ppl

B.Gauthe, J.M.Blum, Compt. rend. 236, 1255(1953).

$\beta^-$ ~0.40* 3rd forbidden? pc

No x ray or $\gamma$

Spectral shape similar to $Rb^{87}$

$\beta$ counts less than background

D.Dixon, McNair, quoted by S.C.Curran, Physica 18, 1161(1952); Nature 170, 512(1952).
*Decimal point as assigned in these references.

**$Re^{188}$** 75 $22^m$ 113

$\tau_1$ **18.7$^m$** Re(slow n)

$\gamma$ **0.06** $\alpha\sim2$ a

p $18^h Re^*$ Szilard-Chalmers chem

A.Flammersfeld, Z. Naturf. 8a, 217(1953); *W.Herr, Z. Naturf. 7a, 819(1952).

$\tau_1$ **22$^m$** $Re^{187}$(pile n)

$\gamma$ **0.0635** s ce$^-$

**0.105**

$\gamma\gamma$ (Re x ray + 0.06$\gamma$)/(0.105$\gamma$) ≥ 10 scin

J.W.Mihelich, Phys. Rev. 89, 907A(1953).

$18^h$ $\gamma$ **0.153** sl

**0.485**

**0.645**

**1.4**

(0.65$\gamma$)(1.4$\gamma$)

C.C.Mullen, M.E.Petch, W.W.Johns, Proc. Roy. Soc. Canada 44, 194A(1950).

$\gamma$ ~130† **0.1553** $\tau = 1.7\times10^{-9}\mu$s

10† **0.4782** sm$\sqrt{2}$ pe$^-$

15† **0.6331**

1† **0.674**

**$Re^{188}$** 75 18h

5† **0.828**

6† **0.931**

1† **1.132**

2† **1.608**

No 1.43$\gamma$ (< 0.5†)

C.C.McMullen, W.W.Johns, Phys. Rev. 91, 418 (1953). Proc. Roy. Soc. Canada 44, 194A(1950).

**$Os^{185}$** 76 109

$\gamma$ **0.163** s ce$^-$

**0.234**

**0.645** K/L~6

**0.879**

J.M.Cork, J.M.LeBlanc, W.H.Nester, D.W.Martin, M.K.Brice, Phys. Rev. 90, 444(1953).

$\gamma$ **0.654** Os (pile n); sl ce$^-$

**0.88**

J.B.Swan, R.D.Hill, Phys. Rev. 88, 831(1952).

**$Os^{191}$** 76 115

$\tau_1$ $14^h$ Os(≤22-Mev $\gamma$) Os(pile n)

No $\beta^-$ (<6%) s$\pi$

$\gamma$ IT **0.0742** s$\pi$ ce$^-$ (Os)

$L_I : L_{II} : L_{III} : M_I : M_{II} : N$

42 : 24 : 100 : 14 : 35 : 15

$14^h$

J.B.Swan, R.D.Hill, Phys. Rev. 88, 831(1952).

$\gamma$ (0.074) E3(73%) M4(27%)

From $\alpha_L$'s, $e_L^-$(0.074 IT $\gamma$)/$e_L^-$(0.13 g.s. $\gamma$), and (Os K x ray)/(Ir K x ray) when produced by Os(n,$\gamma$)

R.D.Hill, J.W.Mihelich, Phys. Rev. 89, 323(1953).

15.0$^d$ $\tau_2$ $15^d$ Os(≤22-Mev $\gamma$) Os(pile n)

$\beta^-$ ~0.14 s$\pi$

$\gamma_1$ 50%* **0.0417** E2

$\gamma_2$ 100%* **0.1291** M1,E2

$K : L_I : L_{II} : L_{III} : M_I : M_{II} : M_{III} : N$

$\gamma_1$ 32 : 40 : — : 11 : 19 : 9.5

$\gamma_2$ 100 : 30 : 11 : 6.0 : ← 12 → : 3.5

$[e_L^-(0.129\gamma)]/[e_L^-(0.042\gamma)]$

*Assuming M1/E2 = 3 for 0.129$\gamma$

J.B.Swan, R.D.Hill, Phys. Rev. 88, 831(1952).

**$Os^{192}$** 76 116

$\tau_{\beta\beta}$ $>10^{14}$y ppl

Assuming decay energy ≥2 Mev

J.M.Fremlin, M.C.Walters, Proc. Phys. Soc. 65A, 911(1952).

**$Os^{193}$** 76 117

$\tau$ $32^h$ Os(pile n),

$\beta^-$ ~1 not Os(≤22-Mev $\gamma$); a

Weak $\gamma$'s with $14^h < \tau < 15^d$

~0.065 0.215 0.323 0.460

J.B.Swan, R.D.Hill, Phys. Rev. 88, 831(1952).

$\gamma$ **0.073** $L_I/L_{II}$~1 **0.404** s ce$^-$

**0.106** L/M~3 **0.460**

**0.139** K/L~5 **0.558**

**0.251**

**0.281** K/L~10

**0.321** K/L~8

J.M.Cork, J.M.LeBlanc, W.H.Nester, D.W.Martin, M.K.Brice, Phys. Rev. 90, 444(1953).

$_{76}Os^{193}_{117}$ $\gamma$ 0.280 0.460 0.560 scin

No 1.58$\gamma$

B.L.Saraf, J.Varma, C.E.Mandeville, Phys. Rev. 91, 1216 (1953).

Ir Neutron resonance (ev) cryst s
0.654

H.H.Landon, V.L.Sailor, M.L.Foote, Jr., Phys. Rev. 90,363A(1953).

$_{77}Ir^{192}_{115}$ $1.4^m$ $\gamma$ (0.057) $\alpha_L$>400 Ir(pile n); pc
Ir L x ray but no unconverted $\gamma$ found

J.M.Kahn, ORNL-1089(1951).

$70^d$ $\beta^-$ 18% 0.24; 40% 0.54; 44% 0.67 s

No 0.84$\beta^-$ (<0.4%)

| | K* | L* | M* |
|---|---|---|---|
| $\gamma$ 0.137 | | ~1.8 | |
| 0.202 | ~0.65 | | |
| 0.207 | 4.3 | 4.0 | 1.2 |
| 0.296 | 18 | 7.4 | |
| 0.309 | 15 | 6.7 | |
| 0.317 | 34 | 18 | 5.5 |
| 0.401 | ~0.1 | | |
| 0.420 | ~0.1 | | |
| 0.440 | ~0.05 | | |
| 0.468 | 7.7 | 2.2 | 0.64 |
| 0.488 | 0.50 | | |
| 0.590 | 0.45 | 0.07 | |
| 0.605 | 1.4 | 0.25 | |
| 0.613 | 0.56 | 0.10 | |
| 0.880 | 4.4** | 1.1** | ~0.5** |

*$(ce^-/\beta)$ x $10^{-3}$ **$(ce^-/\beta)$ x $10^{-6}$

A.A.Bashilov, N.M.Anton'eva, B.S.Dzhelepov, Izvest. Akad. Nauk Ser. Fiz. SSSR 16, 264(1952).

| | | | | |
|---|---|---|---|---|
| $\gamma$ | 0.4† | 0.13633 | 30.0† | 0.46798 |
| | 1.0† | 0.20131 | 1.1† | 0.4848 |
| | 7.5† | 0.20574 | 1.1† | 0.5884 |
| | 38.0† | 0.29594 | 1.4† | 0.6045 |
| | 37.0† | 0.30845 | 0.5† | 0.6129 |
| | 99.0† | 0.31646 | | |

Os K x ray Pt K x ray Ir(pile n), cryst
Level scheme given

D.E.Muller, H.C.Hoyt, D.J.Klein, J.W.M.DuMond, Phys. Rev. 88, 775(1952).

| | | | | |
|---|---|---|---|---|
| $\gamma$ | $2^+$ | 0.200 | 100† | 0.467 |
| | $3^+$ | 0.205 | 5† | 0.486 |
| | $50^+$ | 0.295 | 10† | 0.589 |
| | $50^+$ | 0.307 | 30† | 0.606 |
| | $100^+$ | 0.315 | | |

sl $pe^-$

J.L.Wolfson, Proc. Roy Soc. Canada 44, 193A (1950).

$_{77}Ir^{194}_{117}$ $\gamma$ 100† 0.33 scin
100† 1.48 (E)2 98% (M)1 2%
1† {1.8, 2.1}
(1.48$\gamma$) (0.33$\gamma$) ($\theta$) I = 2,2,0

J.J.Kraushaar, M.Goldhaber, Phys. Rev. 89, 1081 (1953).

$_{78}Pt^{191}_{113}$ $\tau$ $3.2^d$ Ir(10-Mev d) chem, not Pt(≤22-Mev $\gamma$)
$\gamma$ 0.062 0.082 0.094 0.125 0.129 0.171 0.178 0.267 0.350 0.359 0.408 0.455 0.537 s$\pi$ $ce^-$
No 0.042$\gamma$

J.B.Swan, W.M.Portnoy, R.D.Hill, Phys. Rev. 89, 907A; 90, 257(1953).

$_{78}Pt^{193}_{115}$ $4.3^d$ $\tau_1$ $4.5^d$ Ir(10-Mev d) chem Pt(≤22-Mev $\gamma$)
$\gamma$ IT 0.135 M4 s$\pi$
K : $L_I$ : $L_{III}$ : M : N = 10 : 12 : 24 : 13 : 6

J.B.Swan, W.M.Portnoy, R.D.Hill, Phys. Rev. 89, 907A; 90, 257(1953).

$_{78}Pt^{193}_{115}$ g.s. $\tau_2$ $>74^d$ or $<1^h$
Measurements outside these limits obscured by $72^d$Ir and $80^m$Pt

J.B.Swan, W.M.Portnoy, R.D.Hill, Phys. Rev. 90, 257(1953).

$_{78}Pt^{195?}_{117}$ Pt(p,p'$\gamma$) $E_p$ = 2.0
$\gamma$ 0.126 scin
Assignment to $Pt^{192}$ also possible

C.L.McClelland, C.Goodman, Phys. Rev. 91,760(1953).

$_{78}Pt^{198}_{120}$ $\tau_{\beta\beta}$ $>10^{15}$y ppl
Assuming decay energy ≥2 Mev

J.M.Fremlin, M.C.Walters, Proc. Phys. Soc. 65A, 911(1952).

Au Neutron resonance (ev) cryst s
4.93

H.H.Landon, V.L.Sailor, M.L.Foote, Jr., Phys. Rev. 90, 363A (1953).

Neutron resonance
4.85 ev

A.W.Merrison, E.R.Wiblin, Proc. Roy. Soc. 215A, 278(1952).

$_{79}Au^{\geq 183}_{\leq 187}$ $\tau$ $4.3^m$ Pt(120-Mev p); chem
$\alpha$ 5.1 ic

J.O.Rasmussen, jr., S.G.Thompson, A.Ghiorso, Phys. Rev. 89, 33(1953).

$_{79}Au^{195}_{116}$ $30^s$ $\tau$ $30^s$ d $38^h$Hg chem
$\gamma$ 0.056 0.259 sl $ce^-$

O.Huber, R.Joly, P.Scherrer, N.F.Verster, Helv. Phys. Acta 25, 621(1952).

$\gamma$ 0.057 0.262 d $38^h$Hg; s$\pi\sqrt{2}$

K.Gopalakrishnan, A.de-Shalit, J.W.Mihelich, Phys. Rev. 89, 908A(1953).

**$Au^{196}$** 79 117 5.6$^d$

$\gamma$ (0.33) (E)2 95% (M)1 5% $\gamma\gamma(\theta)$
(0.36) (E)2 $\gamma\gamma(\theta)$
$\gamma\gamma(\theta)$ I = 2,2,0
No crossover $\gamma$ (< 1%) scin
$\gamma\gamma(\theta)$ independent of phase and chemical structure

R.M.Steffen, Phys. Rev. 89, 665(1953); 89, 903A (1953).

**$Au^{197}$** 79 118 7.4$^s$

$\gamma$ d 23$^h$ Hg $s\pi$ ce$^-$; scin
IT 0.130 K : $L_I$ : $L_{II}$ : $L_{III}$ : M $\alpha_K \leq 2$
10 : <2 : ~64 : 21 : 36 E3
0.279 K : L $\alpha_K \sim 0.27$
>60 : 10 M1

0.191$\gamma$ , 0.077$\gamma$, previously assigned to decay of 23$^h$ Hg through 7.4$^s$ Au, now assigned to 65$^h$ Hg decay. New assignment based on above E3 0.130 $\gamma$, now resolved from 0.134$\gamma$, and on new threshold for Au(n,n')7.4$^s$ Au of <0.42*

J.W.Mihelich, A.de-Shalit, Phys. Rev. 91, 78 (1953); * H.C.Martin, Ibid.

Au(n,n')7.4$^s$Au
Threshold 0.42

H.C.Martin, B.C.Diven, R.F.Taschek, Phys. Rev. 92, 1096A (1953).

**$Au^{197}$** 79 118

Au(p,p'$\gamma$) $E_p$ = 2.0
$\gamma$'s 0.25? scin
0.45?

C.L.McClelland, C.Goodman, Phys. Rev. 91, 760(1953).

**$Au^{198}$** 79 119

$\tau$ 2.697$^d$ ± 0.003 Au(pile n)
Counted for 10 days $\beta$ electroscope

E.E.Lockett, R.H.Thomas, Nucleonics 11, No. 3, 14(1953).

$\beta^-$ 0.958 sl
1.370 $\Delta I = 3$, yes

J.L.Wolfson, L.G.Elliott, Proc. Roy. Soc. Canada 46, 142A(1952).

$\gamma$ 0.411770 ± 0.000036 cryst

D.E.Muller, H.C.Hoyt, D.J.Klein, J.W.M.DuMond Phys. Rev. 88, 775(1952).

$\gamma$ 0.41173 ± 0.00007 $s\pi\sqrt{2}$ ce$^-$
Compared with 0.51084 Th L line in $Tl^{208}$

A.Hedgran, D.Lind, Arkiv Fysik 5, 177(1952).

$\gamma$ 0.411 $L_I / L_{II}$ = 2.5 E2

J.B.Swan, R.D.Hill, Phys. Rev. 91,424(1953).

$\gamma$ (0.68) (E)2 60% (M)1 40% $\gamma\gamma(\theta)$
(0.68$\gamma$) (0.41$\gamma$) ($\theta$) I = 2,2,0

D.Schiff, F.R.Metzger, Phys. Rev. 90,849(1953).

$\gamma$ (0.68) (E)2 60% (M)1 40% $\gamma\gamma(\theta)$
(0.68$\gamma$) (0.41$\gamma$) ($\theta$) I = 2,2,0

C.D.Schrader, E.B.Nelson, J.A.Jacobs, Phys. Rev. 90, 159(1953).

**$Au^{198}$** 79 119

No $\epsilon_K$ (<0.5%) sl
from absence of Pt Auger e$^-$

C.D.Broyles, D.A.Thomas, S.K.Haynes, Phys. Rev. 89, 715(1953).

**$Au^{200}$** 79 121

$\tau$ 48$^m$ $Hg^{201}$ (≤ 28-Mev $\gamma$) chem
$\beta^-$ 2.2 a
$\gamma$ 0.39 scin
1.13
$\beta/\gamma$ = 5

F.D.S.Butement, R.Shillito, Proc. Phys. Soc. 65A, 945(1952).

**$Au^{201}$** 79 122

$\tau$ 26$^m$ $Hg^{202}$ (≤ 28-Mev $\gamma$) chem
$\beta^-$ 1.5 a
$\gamma$ 0.55 scin
$\beta/\gamma$ = 20

F.D.S.Butement, R.Shillito, Proc. Phys. Soc. 65A, 945(1952).

**$Au^{202}$ ?** 79 123

$\tau$ ~25$^s$ Hg(18-Mev n) chem

F.D.S.Butement, R.Shillito, Proc. Phys. Soc. 65A, 945(1952).

**$Au^{203}$** 79 124

$\tau$ 55$^s$ $Hg^{204}$ (≤ 28-Mev $\gamma$) chem
$\beta^-$ 1.9 a
$\gamma$ 0.69 scin
$\beta/\gamma$ = 10

F.D.S.Butement, R.Shillito, Proc. Phys. Soc. 65A, 945(1952).

**Hg**

Hg(p,p'$\gamma$) $E_p$ = 2.0
$\gamma$ ~0.20 scin

C.L.McClelland, C.Goodman, Phys. Rev. 91,760(1953).

Neutron resonances (ev) $E_n$=0.7 to 1500 ev

| | | |
|---|---|---|
| 23.1* | 91 | 311* |
| 33.3* | 127 | 437 |
| 42.8 | 175* | 1230 |
| 71 | 204 | |

* Most prominent

R.R.Palmer, L.M.Bollinger, Phys. Rev. 91, 450A (1953).

Neutron resonances (ev) $E_n$ = 3 ev to 10 kev

| | $\sigma_o \Gamma^2$ |
|---|---|
| 23.3 | 9 |
| 35.4 | 170 |
| 191 | |
| ~350 | |

E.R.Hodgson, J.F.Gallagher, E.M.Bowey, Proc. Phys. Soc. 65A, 992(1952).

**$Hg^{193}$** 80 113 10$^h$

$\gamma$ 0.039 Au(p)chem; $s\pi\sqrt{2}$ ce$^-$(Hg)
0.102
0.032 $s\pi\sqrt{2}$ ce$^-$(Au)
0.120
0.258

K.Gopalakrishnan, A.de-Shalit, J.W.Mihelich, Phys. Rev. 89, 908A(1953).

$_{80}Hg^{193}_{113}$ $29^h$

$\tau_2$ **27$^h$** Au(p) chem

K.Gopalakrishnan, A.de-Shalit, J.W.Mihelich, Phys. Rev. 89, 908A(1953).

$_{80}Hg^{195}_{115}$ $38^h$

$\gamma$ **0.037** Au(p) chem; s$\pi$2 ce$^-$
**0.123**

K.Gopalakrishnan, A.de-Shalit, J.W.Mihelich, Phys. Rev. 89, 908A(1953).

$\gamma$ **0.036** Au(25-Mev d) chem
$\gamma$ IT **0.122** s1 ce$^-$

O.Huber, R.Joly, P.Scherrer, N.F.Verster, Helv. Phys. Acta 25, 621(1952).

$9.5^h$

$\tau_2$ **9.5$^h$** Au(25-Mev d) chem
$\gamma$ **0.061** s1 ce$^-$
ce$^-$ **0.099**

O.Huber, R.Joly, P.Scherrer, N.F.Verster, Helv. Phys. Acta 25, 621 (1952).

$_{80}Hg^{197}_{117}$ $23^h$

$\gamma$ Au$^{197}$(p,n) s$\pi$ ce$^-$

| | $L_I : L_{II} : L_{III}$ | |
|---|---|---|
| **0.134** | 0.4:11:10 | E2 |
| **0.165** | 10 :<1:15 | M4 |

$65^h$

**0.0774*** 100:45:34 M1+E2
**0.191*** K/L=8

* Previously assigned to 7.4$^s$ Au, q.v.

J.W.Mihelich, A.de-Shalit, Phys. Rev. 91,78(1953)

$_{80}Hg^{198}_{118}$

Level Hg($\gamma,\gamma'$) $E_\gamma$ = 0.411
(0.411) $\tau \sim 1.1\times10^{-11}$*
Source heated to compensate for recoil
*With statistical weight factor S = 1 in
$\sigma$(abs. of 0.411$\gamma$) = kS$\Gamma$f(temp)

K.G.Malmfors, Arkiv Fysik 6, 49 (1953).

Level Hg($\gamma,\gamma'$) $E_\gamma$ = 0.411
(0.411) $\tau \sim 8\times10^{-11}$s*
Source rotated to compensate for recoil
*With statistical weight factor S = 5 in
$\sigma$(abs. of 0.411$\gamma$) = kS$\Gamma$f(velocity)

P.B.Moon, A.Storruste, Proc. Phys. Soc. 66A, 585 (1953).

$_{80}Hg^{199}_{119}$ $43^m$

$\gamma$ **0.159** $L_{II}/L_{III}$ = 1.6 E2

J.B.Swan, R.D.Hill, Phys. Rev. 91, 424 (1953).

$_{80}Hg^{200}_{120}$

Capture $\gamma$ Hg(n,$\gamma$) s$\pi$ ce$^-$
**$\sim$0.28**

C.T.Hibdon, C.O.Muehlhause, Phys. Rev. 88, 943 (1952); 87, 222A(1952).

$_{80}Hg^{203}_{123}$

$\gamma$ (0.28) $\tau < 2\times10^{-9}$s $\beta\gamma$

T.C.Engelder, Phys. Rev. 90, 259(1953).

$\gamma$ (0.28) M1 + E2
$L_I : L_{II} : L_{III}$ = 2.85: 2.08: 1.0

J.B.Swan, R.D.Hill, Phys. Rev. 91, 424 (1953).

Tl Tl(p,p$'\gamma$) $E_p$ = 2.0
$\gamma$ **0.38** scin

C.L.McClelland, C.Goodman, Phys. Rev. 91, 760 (1953).

$_{81}Tl^{198}_{117}$ $1.8^h$

$\tau_1$ **$\sim$2$^h$** Hg(10-Mev d)
$\gamma$ **0.260** M4 s ce$^-$
**0.282** M1

I.Bergström, R.D.Hill, Phys. Rev. 92, 849A (1953).

$4^h$

$\tau_2$ **4$^h$** Hg(10-Mev d)
$\gamma$ **0.411**
**0.675**

I.Bergström, R.D.Hill, Phys. Rev. 92, 849A (1953).

$_{81}Tl^{203}_{122}$

$\mu(Tl^{203})/\mu(Tl^{205})$ = 0.990258 ± 0.000001 I

Resonance frequencies depend on anions in solution; shifts same for $Tl^{203}$,$Tl^{205}$

H.S.Gutowsky, B.R.Garvey, Phys. Rev. 91, 81(1953).

$_{81}Tl^{204}_{123}$

$\tau$ **4.02$^y$** ± 0.12 Tl(n,$\gamma$) chem
Counted over period of 2.8 y. after cooling 2.7 y

G.Harbottle, Phys. Rev. 91, 1234 (1953).

$\tau$ **2.71$^y$** ± 0.05 Tl(pile n)
Counted for 8 months $\beta$ electroscope

E.E.Lockett, R.H.Thomas, Nucleonics 11, No. 3, 14(1953).

$\beta^-$ 98.5% **0.760** $\Delta I = 2$, yes shape 4$\pi$ scin
$\epsilon$ $\sim$1.5%

$E_{dis}(\epsilon) \sim 0.4$ (calc)
No 0.37$\gamma$ ($< 10^{-2}$%)

E.der Mateosian, A.Smith, Phys. Rev. 88, 1186 (1952).

$_{81}Tl^{206}_{125}$

$\tau$ **4.19$^m$** ± 0.02 Tl(pile n)
Counted for 25 half-lives $\beta$ electroscope

B.W.Sargent, L.Yaffe, A.P.Gray, Can. J. Phys. 31, 235(1953).

$_{81}Tl^{207}_{126}$

$\tau$ **4.79$^m$** ± 0.02 $Bi^{211}$ recoil
Counted for 25 half-lives $\beta$ electroscope

B.W.Sargent, L.Yaffe, A.P.Gray, Can. J. Phys. 31, 235(1953).

$_{81}Tl^{208}_{127}$

$\gamma$ 0.05† **0.27735** $Th^{228}$ source, cryst
0.15† **0.5108**
0.40† **0.5830**
0.24098$\gamma$ (0.10†) unassigned
† Relative to 0.238$\gamma$ of $Pb^{212}$

D.E.Muller, M.C.Hoyt, D.J.Klein, J.W.M.DuMond, Phys. Rev. 88, 775(1952).

$\gamma$ (2.62) $\alpha_{pair} = 4.3\times10^{-4}$ E2 s

M.Slätis, K.Siegbahn, Arkiv Fysik 4, 485(1952).

**$Tl^{208}$** 81 127

No 5.1 $\beta$ (<0.2%)

P.E. Cavanagh, quoted by P.Marin, G.R.Bishop, H. Halban, Proc. Phys. Soc. 66A, 608 (1953).

(0.58$\gamma$)(2.62$\gamma$) polarization-direction
I = 4†, 2†, 0†

J.J.Kraushaar, W.Goldhaber, Phys. Rev. 89, 1081 (1953).

**$Tl^{209}$** 81 128

| | | | |
|---|---|---|---|
| $\beta^-$ | 1.99 | | d $10^d$Ac; s |

F.Wagner, Jr., M.S.Freedman, D.W.Engelkemeir, L.B.Magnusson, Phys. Rev. 88, 171A(1952).

**Pb** Variations in relative isotopic abundances

C.B.Collins, R.W.Farquhar, R.D.Russell, Phys. Rev. 88, 1275(1952).

Pb(p,p) $E_p$ = 1.8

No $\gamma$ observed scin

T.Huus, Č.Zupančič, Kgl. Danskab. Sekskab, Mat-fys. Medd. 28, No. 1 (1953).

Pb(n,n'$\gamma$) $E_n$ = 3.7 scin

| Level | |
|---|---|
| $\gamma$ | 2.65 |

M.A.Rothman, D.W.Kent, C.E.Mandeville, Phys. Rev. 92, 1097A(1953); J.Franklin Inst. 256, 278 (1953).

**$Pb^{200}$** 82 118

| | | | |
|---|---|---|---|
| $\gamma$ | 0.139 | Tl(60-Mev d) chem | |
| | 0.320 | s$\pi\sqrt{2}$ $ce^-$ | |

G.D.O'Kelley, UCRL-1243(1951).

**$Pb^{201}$ ?** 82 119 $50^s$

| | | | | |
|---|---|---|---|---|
| $\tau_1$ | | $50^s$ | Tl(p) | chem, not Hg(p) |
| $\gamma$ | ~1† | 0.25 | | scin |
| | ~1† | 0.42 | | |
| | ~4† | 0.67 | | |

N.J.Hopkins, Phys. Rev. 88, 680(1952).

**$Pb^{202}$ ?** 82 120 $5.6^s$

| | | | |
|---|---|---|---|
| $\tau_1$ | $5.6^s$ | Tl(p), not Hg(p) | |
| $\gamma$ | 0.89 | scin | |

N.J.Hopkins, Phys. Rev. 88, 680(1952).

**$Pb^{203}$** 82 121

| | | | |
|---|---|---|---|
| $\gamma$ | 0.153 | Tl(60-Mev d) chem | |
| | 0.269 | K/L = 2.3 | s$\pi\sqrt{2}$ $ce^-$ |
| | 0.424 | | |

G.D.O'Kelley, UCRL-1243(1951).

**$Pb^{205}$** 82 123

Levels $Pb^{206}$(d,t) $E_d$ = 14 a pc

0.3
0.8
1.8

J.A.Harvey, Can. J. Phys. 31, 278(1953).

**$Pb^{206}$** 82 124

Levels $Pb^{207}$(d,t) $E_d$ = 14 a pc

| | |
|---|---|
| 0.9 | 2.2 |
| 1.4 | 3.0 |
| 1.7 | |

J.A.Harvey, Can. J. Phys. 31, 278(1953).

**$Pb^{207}$** 82 125 $0.8^s$

$\tau_1$ $0.80^s$

N.J.Hopkins, Phys. Rev. 88, 680(1952).

$\tau_1$ $0.9^s$ d $50^y$ Bi chem

G. Friedlander, E.Wilson, A.Ghiorso, I.Perlman, Phys. Rev. 91, 498A (1953).

**$Pb^{207}$** 82 125

| Levels | $Pb^{206}$(d,p) | $Pb^{208}$(d,t) |
|---|---|---|
| | 0.6 | 0.6 |
| | 1.0 | 1.0 |
| | 2.8 | 1.6 |
| | 3.6 | 2.3 |
| | 4.4 | |
| | 4.7 | |
| | 5.3 | |

$E_d$ = 14 a pc

J.A.Harvey, Can. J. Phys. 31, 278(1953).

**$Pb^{208}$** 82 126

| Levels | $Pb^{207}$(d,p) | | $E_d$ = 14 | a pc |
|---|---|---|---|---|
| | 3.4 | 5.4 | | |
| | 3.6 | 6.1 | | |
| | 5.1 | | | |

J.A.Harvey, Can. J. Phys. 31, 278(1953).

**$Pb^{209}$** 82 127

| | | | |
|---|---|---|---|
| $\beta^-$ | 0.63 | d $10^d$Ac | chem; s, scin |

F.Wagner, Jr., M.S.Freedman, D.W.Engelkemeir, L.B.Magnusson, Phys. Rev. 88, 171A(1952).

Levels $Pb^{208}$(d,p) $E_d$ = 14 a pc

| | |
|---|---|
| 0.8 | 2.0 |
| 1.6 | 2.5 |

J.A.Harvey, Can. J. Phys. 31, 278(1953).

**$Pb^{210}$** 82 128

| | | |
|---|---|---|
| $\beta^-$ | 0.015 | pc |

No nuclear 0.007$\beta$ (Cu x ray?)

A.A.Jaffe, S.G.Cohen, Phys. Rev. 89, 454(1953).

| | | |
|---|---|---|
| $\beta^-$ | 0.024 | pc |

F-K plot linear to 8.5 kev

E.Huster, Naturwiss. 40, 197(1953).

$\gamma$ (0.047) L : M : N = 100 : 23 : 6 EA

$ce^-$ 0.0110 not assigned

No $ce^-$(0.014-0.030) <1% of $ce^-_L$(0.046?$\gamma$)

Y.Kobayaski, G.Miyamoto, J. Phys. Soc. Japan 8, 135(1953); 273(1953).

| | | | | |
|---|---|---|---|---|
| $\gamma$ | 7† | 0.0465 | $\alpha$ = 12 | pc s$\pi$ |
| | | $L_I : L_{II} : L_{III}$ : M : NO | | |
| | | 100:7.5:0.7:26:7.7 | | M1 |

No other $\gamma$(< 0.5%)

†Photons per 100 disintegrations

C.S.Wu, F.Boehm, E. Nagel, Phys. Rev. 91, 319; 90, 388A(1953).

| | | |
|---|---|---|
| $\gamma$ | 0.04652 | cryst |

No other $\gamma$'s from 0.016 to 0.062 (< 2%)

G.T.Ewan, M.A.S.Ross, Nature 170, 760(1952).

**$Pb^{210}$** 82 128

(L x ray) / (0.047γ) = 6.3 pc
Peaks seen ascribed to nuclear γ's of
16.1, 24, 30.7, 37.0, 41.5, 62.5 kev

P.E.Damon, R.R.Edwards, Phys. Rev. 90, 280(1953).

**$Pb^{212}$** 82 130

$\tau$ $10.64^h \pm 0.03$
Measured for 3 half-lives with ic

P. Marin, G.E.Bishop, H.Halban, Proc. Phys. Soc. 66A, 608 (1953).

$\tau$ $10.67^h$

H.Buttar, Naturwiss. 39, 575(1952).

γ 0.23860 cryst

D.E.Muller, H.C.Hoyt, D.J.Klein, J.W.M.DuMond, Phys. Rev. 88, 775(1952).

γ 0.23863 s
Hρ(F) = 1388.56 ± 0.21
H determined (2-20 kev) with $e^-$ accelerated through known potential

D.I.Meyer, F.H.Schmidt, Phys. Rev. 89, 908A (1953).

γ (0.238) $\tau < 2 \times 10^{-11}$ s $\beta e_K^-$

R.L.Graham, R.E.Bell, Can. J. Phys. 31, 377(1953).

**$Pb^{214}$** 82 132

$\beta^-$ 0.35 ? s $\beta e^-$
33 † 0.67
100 † ~0.73
γ 4.3* 0.241 s $ce^-$
4.8* 0.294
3.5* 0.350
[0.67β] [$e_K$(0.35γ)]
[0.73β] [$e_K$(0.29γ)]
*$ce^-$ per 100 $\beta^-$

E.E.Berlovich, Izvest. Akad. Nauk Ser. Fiz. SSSR 16, 314(1952).

γ 0.053226 $Rn^{222}$ source, cryst
20 † 0.24192
55 † 0.29522
100 † 0.35199

D.E.Muller, H.C.Hoyt, D.J.Klein, J.W.M.DuMond, Phys. Rev. 88, 775(1952).

γ 0.292 sl $pe^-$
0.350

R.M.Pearce, K.C.Mann, Can. J.Phys. 31,592(1953).

**$Bi^{208}$** 83 125

Bi(d,t) $E_d$ = 14 a pc
Q values −1.17 (g.s. value?)
−1.8
−2.2

J.A.Harvey, Can. J. Phys. 31, 278(1953).

**$Bi^{209}$** 83 126

μ 4.0400 $Bi(No_3)_3$, $D_2O$; I
$\nu(Bi^{209})/\nu(D) = 1.04684 \pm 0.00005$

Y.Ting, D.Williams, Phys. Rev. 89, 595(1953).

**$Bi^{209}$** 83 126

$\tau$ $2 \times 10^{17}$ y ppl
α 2.9
7 α tracks, $E_\alpha$ = 2.9, in Bi impregnated plate kept 100 days in $N_2$, 18°C

W.Riezler, W.Porschen, Z. Naturforsch. 7a, 634 (1952).

Very few low energy α's in Bi loaded plate
$\tau$ of $2 \times 10^{17}$ y, $E_\alpha$ of 3 Mev not confirmed

E.P.Hincks, C.M.Millar, Proc. Roy. Soc. Canada 46, 143A(1952).

**$Bi^{210}$** 83 127 $4.9^d$

$\tau_2$ $4.989^d \pm 0.013$ Bi(pile n)
Counted for 33 days β electroscope

E.E.Lockett, R.H.Thomas, Nucleonics 11, No. 3, 14(1953).

**$Bi^{210}$** 83 127

β spectrum shape from $E_\beta$ = 0.005 to 0.10 sl
Number β's does not approach 0 as $E_\beta \longrightarrow 0$

J.Pniewski, Acta Phys. Polon. 11, 215(1953); Nature 171, 694 (1953).

No 0.080γ (< 0.02% of β's) scin

D.G.E.Martin, G.Parry, Phil. Mag. 44, 344(1953).

**$Bi^{210}$** 83 127 $4.9^d$

No $ce^-$, no nuclear γ pc sπ

C.S.Wu, F.Boehm, E.Nagel, Phys. Rev. 91,319; 90, 388A(1953).

Continuous γ spectrum scin
$\gamma(E_\gamma > 0.09)/\beta^- = 0.00084$

P.Bolgiano, L.Madansky, F.Rasetti, Phys. Rev. 89, 679(1953).

Bi(d,p) $E_d$ = 15 scin
Q value 1.94
No higher energy p group (< 3% of Q = 1.94 group) but believed not g.s. Q

N.S.Wall, Phys. Rev. 91,485A(1953).

Bi(d,p) $E_d$ = 14 a pc
Q values 1.94 −0.3
0.30 −0.8

J.A.Harvey, Can. J. Phys. 31, 278(1953).

**$Bi^{211}$** 83 128

γ (0.35) $\tau \leq 1.2 \times 10^{-9}$ s α $ce^-$
(6.272α) (0.35γ) (θ) isotropic

S.Gorodetzky, A.Gallman, A.Knipper, R.Armbruster, Compt. rend. 237, 245 (1953).

**$Bi^{212}$** 83 129

α 6.051* s
6.090
*Value of 6.046 (Nature 167, 682) in error

E.R.Collins, C.D.McKenzie, C.A.Ramm, Proc. Roy. Soc. 216A, 219(1953).

α 35.4% ic
$\beta^-$ 64.6%

P.Marin, G.R.Bishop, H.Halban, Proc. Phys. Soc. 66A, 608 (1953).

**$Bi^{212}$** 83 129

$\gamma$ (0.040) $\tau < 7 \times 10^{-11}$ s $\alpha e_L$

R.L.Graham, R.E.Bell, Can. J. Phys. 31, 377(1953).

$\gamma$ 0.15† **0.729** $Th^{228}$ source, cryst

†Relative to 0.238$\gamma$ of $Pb^{212}$

D.E.Muller, H.C.Hoyt, D.J.Klein, J.W.M.DuMond, Phys. Rev. 88, 775(1952).

(6.04$\alpha$) (0.04$\gamma$) ($\theta$) b=1.30 I= 1,3,4 or 1,4,5

J.Horton, R.Sherr, Phys. Rev. 90,388A(1953).

**$Bi^{213}$** 83 130

$\beta^-$ **0.96** d $10^d$Ac chem; s
**1.39**

$\gamma$ **0.120**
**0.435**

(1.39$\beta$) (0.12$\gamma$)

F.Wagner, Jr., M.S.Freedman, D.W.Engelkemeir, L.B.Magnusson, Phys. Rev. 88, 171A(1952).

**$Bi^{214}$** 83 131

$\beta^-$ 81% ~1.55 $Ra^{226}$ source a$\beta\gamma$
< 10% (2.56) a
19% (3.17) a

$E_{dis}$ = 3.17

A.H.Wapstra, Physica 18, 1247(1952).

$\gamma$ **0.452** **0.932** **1.750**
**0.500** **1.123** **1.800**
**0.607** **1.236** **2.192**
**0.783** **1.400**
**0.860** **1.525** sl $pe^-$

R.M.Pearce, K.C.Mann, Can. J. Phys. 31,592(1953).

$\gamma$ 1.6† **0.6094** $Rn^{222}$ source, cryst

†Relative to 0.352$\gamma$ of $Pb^{214}$

D.E.Muller, H.C.Hoyt, D.J.Klein, J.W.M.DuMond, Phys. Rev. 88, 775(1952).

$\gamma$ **0.605** **1.379** s$\pi$ Cpt line
**0.699*** **1.504*** **1.832***
**0.770** **1.627**** **2.116****
**0.907** **1.679**** (2.193)
(1.120) **1.727**** **2.42****
**1.247** (1.761)

( ) Used as standards
* $ce^-_K$ seen by Ellis but assigned otherwise
** $ce^-$ seen by Ellis but not assigned

M.Mladjenović, A.Hedgran, Physica 18, 1242(1952).

$\gamma$ **1.1205** s$\pi$ $ce^-_K$
**1.4158**

$H_\rho$ = 4939.8 ± 0.8, 5874.4 ± 0.6 gauss cm

G.Lindström, A.Hedgran, D.E.Alburger, Phys. Rev. 89, 1303(1953).

$\gamma\gamma(\theta)$ b ~0.3

F.Demichelis, R.Malvano, Nuovo Cimento 9, 1106 (1952).

**$Bi^{215}$** 83 132

$\tau$ **8$^m$** d $0.9^m$$At^{219}$ p $2^{m s}$$Po^{215}$

E.K.Hyde, A.Ghiorso, Phys. Rev. 90, 267(1953).

**$Po^{206}$** 84 122

$\alpha$ 5% d $2.3^h$$Rn^{210}$

F.F.Momyer, UCRL-2060(1953).

**$Po^{210}$** 84 126

$\tau$ **138.39$^d$** ± 0.14
Observed for 200 days calorimeter

D.C.Ginnings, A.F.Ball, D.T.Vier, J. Research Nat. Bur. Standards 50, 75(1953); J. Franklin Inst. 255, 241(1953).

**$Po^{211}$** 84 127

Not parent $0.8^s$ Pb (< 0.003%) chem

G.Friedlander, E.Wilson, A.Ghiorso, I.Perlman, Phys. Rev. 91, 498A (1953).

**$Po^{212}$** 84 128

$\tau$ **$2.9 \times 10^{-7}$ s** $\beta\gamma$

T.Hayashi, Y.Ishizaki, I.Kumabe, J. Phys. Soc. Japan 8, 110(1953).

**$Po^{214}$** 84 130

$\tau$ **$1.58 \times 10^{-4}$ s** $\beta n$

R.Ballini, Ann. Phys. 8, 441 (1953).

**$Po^{218}$** 84 134

$\alpha$ **5.996** s

G.Bastin-Scoffier, J. Sant'ana-Dionisio, Compt. rend. 236, 1016(1953).

$\beta^-$ 0.022% ic

F.Hiessberger, B.Karlik, Sitzber. Akad. Wiss. Wien, Math-naturw. Kl. Abt. II a 161, 51 (1952).

**$At^{211}$** 85 126

$\alpha$ **5.862**

R.W.Hoff, F.Asaro, quoted by F.F.Momyer, UCRL-2060(1953).

**$At^{219}$** 85 134

$\tau$ **0.9$^m$** d $21^m$$Fr^{223}$ chem
$\alpha$ **6.27** ic
$\alpha/\beta^-$ = 30

E.K.Hyde, A.Ghiorso, Phys. Rev. 90, 267(1953).

**$Rn^{208}$** 86 122

$\tau$ **23$^m$** p $4^h$$Po^{204}$ Th(340-Mev p)
$\epsilon$ ~80%
$\alpha$ ~20% **6.138** s

F.F.Momyer, UCRL-2060(1953).

**$Rn^{209}$** 86 123

$\tau$ **30$^m$** p $5.7^h$$At^{209}$ Th(340-Mev p)
$\epsilon$ ~85%
$\alpha$ ~15% **6.04** s

F.F.Momyer, UCRL-2060(1953).

**$Rn^{210}$** 86 124

$\tau$ **2.7$^h$** p $9^d$$Po^{206}$ Th(340-Mev p)
$\epsilon$ < 5%
$\alpha$ > 95% **6.036** s

F.F.Momyer, UCRL-2060(1953).

**$Rn^{211}$** 86 125

$\tau$ **16$^h$** Th(340-Mev p)
$\epsilon$ 74%
$\alpha$ 17% **5.778** s
9% **5.847**
$\gamma$ **0.07** scin
**0.15**
**0.40**
**0.60**

F.F.Momyer, UCRL-2060(1953).

**$Rn^{212}$** 86 126

$\alpha$ 6.262 Th(340-Mev p) s

F.F.Momyer, UCRL-2060(1953).

**$Rn^{220}$** 86 134

$\alpha$ 6.278 s

G.Bastin-Scoffier, J.Sant'ana-Dionisio, Compt. rend. 236, 1016(1953).

**$Rn^{221}$** 86 135

$\tau$ $25^m$ Th(110-Mev p)
$\beta^-$ ~80%
$\alpha$ ~20%

F.F.Momyer, UCRL-2060(1953).

**$Rn^{222}$** 86 136

$\alpha$ 5.482 s

G.Bastin-Scoffier, J.Sant'ana-Dionisio, Compt. rend. 236, 1016(1953).

**$Fr^{212}$** 87 125

| | | |
|---|---|---|
| $\alpha$ | 24% | 6.339 |
| | 39% | 6.387 |
| | 37% | 6.409 |

s

E.K.Hyde, F.Asaro, quoted by F.F.Momyer, UCRL-2060(1953).

**$Fr^{223}$** 87 136

$\alpha/\beta^-$ $\sim 4 \times 10^{-5}$

E.K.Hyde, A.Ghiorso, Phys. Rev. 90, 267(1953).

**$Ra^{213}$** 88 125

$\tau$ $2.7^m$ p $30^m Rn^{209}$ $Pb(C^{12})$
$\alpha$ 6.90 ic

F.F.Momyer, UCRL-2060(1953).

**$Ra^{223}$** 88 135

$\tau$ $11.1^d$ $Rn^{222}$(pile n,$\gamma/\beta$) chem

A.P Baerg, Phys. Rev. 90, 1121 (1953).

**$Ra^{224}$** 88 136

$\alpha$ 5.679 s

G.Bastin-Scoffier, J.Sant'ana-Dionisio, Compt. rend. 236, 1016(1953).

**$Ra^{226}$** 88 138

$\alpha$ 5.7% (4.611) s, ppl
No $\alpha$'s from 3.6 to 4.4 (<0.02%)* ic

F.Asaro, I.Perlman, Phys. Rev. 88, 129(1952).
*A.Ghiorso, Ibid.

$\alpha$ $4.777 \pm 0.004$ s
Based on $E_\alpha$(Po) = 5.299

G.Bastin-Scoffier, J.Sant'ana-Dionisio, Compt. rend. 236, 1016(1953).

$\gamma$ (0.188) $\alpha = 0.9^*$ E2 $\alpha e^-$
*Assuming 4.611$\alpha$ in 6.4% of disintegrations

C.Victor, J.Teillac, P.Falk-Vairant, G.Boussieres, J. phys. radium 13, 565(1952).

**$Ra^{227}$** 88 139

| | | | |
|---|---|---|---|
| $\tau$ | | $41.2^m$ | $Ra^{226}$(n,$\gamma$)chem |
| $\beta^-$ | | 1.31 | a |
| $\gamma$ | 4.0† | 0.291 | scin |
| | 0.6† | 0.498 | |
| x | 3.1† | K x ray | |

†Photons per 100 $\beta^-$

J.P.Butler, J.S Adam, Phys. Rev. 91, 1219 (1953).

**$Ac^{228}$** 89 139

| | | | |
|---|---|---|---|
| $\beta^-$ | 13% | 0.45 | d $Ra^{228}$ sm $\beta\gamma$ |
| | 8% | 0.64 | chem |
| | 53% | 1.11 | |
| | 7% | 1.70 | sm |
| | 9% | 1.85 | |
| | 10% | 2.18 | |
| $\gamma$ | | 0.0567 | sm $ce^-$ |
| | | 0.078 | |
| | | 0.0978 0.232 0.965 | |
| | | 0.113 0.336 1.035 | |
| | | 0.1275 0.410 1.095 | |
| | | 0.179 0.458 1.587 | |
| | | 0.184 0.907 1.640 | |

(0.45$\beta$,0.64$\beta$) (>1.1$\gamma$) (1.11$\beta$) (~1$\gamma$)
(1.70$\beta$, 1.85$\beta$) (>0.9$\gamma$) No (2.18$\beta$) ($\gamma$)
(0.098 $ce^-_L$, 0.127 $ce^-_L$, 0.184 $ce^-_L$) ($\gamma$)
No (0.127 $ce^-$) (0.184 $ce^-$) No (>0.9$\gamma$) (>0.9$\gamma$)
(~0.45$\gamma$) (~1.0$\gamma$) (~0.9$\gamma$) (<0.4$\gamma$)
No (~0.45$\gamma$) (>1.1$\gamma$)
No $\beta$(soft $e^-$) delay observed; implies
$500^{\mu s} > \tau(0.057\gamma) > 0.1^{\mu s}$ or $>0.01^s$

J.Kyles, C.G.Campbell, W.J.Henderson, Proc. Phys. Soc. 66A, 519 (1953).

**Th** Neutron resonances (ev) $E_n$ = 2 ev to 2 kev
25 $\sigma_o \Gamma^2 = 84$
80
170

E.R.Hodgson, J.F.Gallagher, E.M.Bowey, Proc. Phys. Soc. 65A, 992(1952).

**$Th^{228}$** 90 138

| | | | |
|---|---|---|---|
| $\alpha$ | 0.2% | 5.173 | s |
| | 0.4% | 5.208 | |
| | 28 % | 5.388 | |
| | 71 % | 5.421 | |
| $\gamma$ | | 0.089 $\alpha \sim 16$ | scin |
| | | 0.137 $\alpha \ll 1$ | |
| | | 0.169 $\alpha \sim 1.2$ | |
| | | 0.212 $\alpha \ll 1$ | |

F.Asaro, F.Stephens, Jr., I.Perlman, UCRL-2244(1953).

$\gamma$ (0.084) $\alpha = 12^*$ E2 $\alpha e^-$
*Based on $\gamma/\alpha = 0.02^{**}$

C.Victor, J.Teillac, P.Falk-Vairant, G.Boussieres, J. phys. radium 13, 565(1952); **M.Riou, Ibid.

| | | | |
|---|---|---|---|
| $\gamma$ | 100† | (0.084) | $Th^{228}$ extracted |
| | 14† | 0.133 | from $Ra^{228}$ |
| | 10† | 0.172 | |
| | 17† | 0.216 | scin |

Decay products continuously removed

G.Boulssieres, P.Falk-Vairant, M.Riou, J.Teillac, C.Victor, Compt. rend 236, 1874 (1953).

($\alpha$) (0.083$\gamma$) ($\theta$) does not agree with I = 0, I, 0
$\tau(0.083\gamma) < 10^{-8s}$ Source $Th(OH)_4$
No (0.0868$\gamma$) ($\alpha$) No $\gamma\gamma$

J.Battey, L.Madansky, F.Rasetti, Phys. Rev. 89, 182(1953).

**$Th^{230}$** 90 140

| | | | |
|---|---|---|---|
| $\gamma$ | 33† | (0.087) | 9% $Th^{230}$ scin |
| | 4† | 0.150 | |
| | ~0.3† | 0.20? | |

**$Th^{230}$** 90 140

1† 0.254
x 660† L x ray
†Photons per $10^4$ disintegrations

G.Boulssieres, P.Falk-Vairant, M.Riou, J.Teillac, C.Victor, Compt. rend. 236, 1874 (1953).

$\gamma$ 105† **0.068** $\tau < 0.3^{\mu s}$ 10% $Th^{230}$
14† **0.142** scin
5† **0.255**
x 1170† L x ray
(0.14$\gamma$) (0.068$\gamma$) No(0.068$\gamma$) (L x ray)
No(0.25$\gamma$) (0.068$\gamma$) No(0.25$\gamma$) (0.14$\gamma$)
†Photons per $10^4$ disintegrations

F.Rasetti, E.C.Booth, Phys. Rev. 91, 315; 90,388A (1953).

$\gamma$ (0.070) L/M = 12 cc
$ce^-/\alpha = 0.17$
($\alpha$) ($ce_L^-$) ($\theta$) graph

R.R.Roy, M.L.Goes, Nature 172, 360 (1953).

$\alpha$ ~0.03% **4.44** ~100% $Th^{230}$ ms
~0.12% **4.47** 1c
(25%) (4.612)
(75%) (4.682)
(4.47$\alpha$) ($ce^-$) (4.61$\alpha$) ($ce^-$)
No (4.44$\alpha$) ($ce^-$) No (4.68$\alpha$) ($ce^-$)

G.Valladas, R.Bernas, Compt. rend. 236,2230(1953).

($\alpha$) (0.068$\gamma$) ($\theta$) I = 0, 2, 0 scin

G.M.Temmer, J.M.Wyckoff, Phys. Rev. 92, 849A(1953).

**$Th^{232}$** 90 142

$\gamma$ **0.075** ppl
$e^-/\alpha = 0.2$

G.Albouy, J. phys. radium 13, 309(1952).

**$Th^{234}$** 90 144

$\beta^-$ 33% **0.103** $Th^{234}$ + $Pa^{234}$ source
67% **0.193** sc$\mathcal{N}$2
$\gamma$ **0.0294** sc$\mathcal{N}$2 $ce^-$
**0.0431**
**0.0471?**
**0.0630**
**0.0914** $L_I:M_I:N_I$ = 83:21:5.7
**0.1002**
$[ce^-_{L_I}$ (0.091$\gamma$)]/$\beta$ = 0.083
$\gamma$'s could belong to $Pa^{234}$

P.H.Stoker, W. Heerschap, O.P.Hok, Physica 19, 433 (1953).

**$Pa^{231}$** 91 140

$\gamma$ (0.027) $\tau$=4.2x$10^{-8}$s $\alpha\gamma$
$\alpha_L \sim 7$ E1 a

J.Teillac, M. Riou, P. Desneiges, Compt. rend. 237, 41 (1953).

$\gamma$ **0.0273** $\alpha < 10$ E1 a
**0.0336** $ce^-$, ppl
**0.0380**
**0.0569** } $L_I + L_{II} \simeq L_{III}$ E2
**0.0635**

**$Pa^{231}$** 91 140

**0.0823** $L_I \simeq M_I$
Rel. intensity of $ce^-$
**0.102** $L_{II}:L_{III}:M$ = 2 : 2 : 2
**0.198** K : L = 2 : 5
**0.259** K : L =10: 5
**0.301** K : L :M=100:20: 7
$\alpha_K \sim 1.6$ M1
**0.331** K : L :M=50:10: 1
$\alpha_K \sim 1.6$ M1
**0.357** K : L =10: 2
**0.383** K = 5
Unassigned $ce^-$ 0.125, 0.135, 0.170

P.Falk-Vairant, M.Riou, J. Phys. Radium 14, 65 (1953); P. Falk-Vairant, Compt. rend. 235, 796 (1952).

$\gamma$ **0.044** cc
**0.066**

J.Teillac, Ann. Phys. 7, 396(1952).

**$Pa^{234}$** 91 143 1.14$^m$

$\tau_1$ **1.175$^m$**

F.Barendregt, Sj.Tom, Physica 17, 817(1951).

$\beta^-$ 1% **0.580** $Th^{234}$+$Pa^{234}$ source
9% **1.500** sc$\mathcal{N}$2
90% **2.305** e$^1$
$\gamma$ **0.229** converted in Pa
**0.316**
**0.810** $\alpha_K \sim 0.06$ K/L = 5.2
**0.845**
**0.877**
No 0.395$\gamma$ ($ce^-_{LM}/\beta^- < 3x10^{-4}$)
See $Th^{234}$ for possible $\gamma$'s

P.H.Stoker, W.Heerschap, O.P.Hok, Physica 19, 433 (1953).

6.7$^h$

$\beta^-$ ~75% ~0.50 U chem sl
~18% **0.90**•
~ 7% **1.35**•
**0.104? 0.276** sl $ce^-$
**0.126? 0.60**
**0.160? 0.76**
**0.230 0.86**
•Could be single spectrum of 0.98 (25%)

G.Boulssieres, N.Marty, J.Teillac, Compt. rend. 237, 324 (1953).

**U**

Neutron resonances (ev) $E_n$ = 3.7 to 800 ev
**6.6** $\sigma_0$ = 5000 $\Gamma$ = 0.05
**20** $\sigma_0\Gamma^2$ = 4.5
**38** $\sigma_0\Gamma^2$ = 6.5

E.Hellstrand, R.Persson, Arkiv Fysik 6, 57(1953).

**$U^{233}$** 92 141

$\gamma$ 5† **0.0428** pc
1† **0.0561**
(L x ray)/$\alpha$ = 0.04
†Photons per $10^4$ $\alpha$'s

D.West, J.K.Dawson, C.J.Mandleberg, Phil. Mag. 43, 875(1952).

**$_{92}U^{233}_{141}$**

$\gamma_1$ ~0.040 ppl
$\gamma_2$ (0.056)
$\gamma_3$ (0.099)

$\alpha+e_1^-$, $\alpha+e_1^-+e_2^-$, $\alpha+e_3^-$ tracks

$(\alpha+e_1^-)/(\alpha+e_1^-+e_2^-)\sim 70$ $(\alpha+e^-)/\alpha = 0.09$

K.W.Bisgård, Proc. Phys. Soc. 65A, 677(1952).

**$_{92}U^{234}_{142}$**

$\tau$ $2.475 \times 10^5$ y ±0.016 chem, ms; ic 95.99% $U^{234}$

E.H.Fleming, Jr., A.Ghiorso, B.B.Cunningham, Phys. Rev. 88, 642(1952).

**$_{92}U^{235}_{143}$**

$\tau$ $7.13 \times 10^8$ y ±0.16 chem, ms; ic 99.94% $U^{235}$

E.H.Fleming, Jr., A.Ghiorso, B.B.Cunningham, Phys. Rev. 88, 642(1952).

**$_{92}U^{236}_{144}$**

$\tau$ $2.391 \times 10^7$ y ±0.018 chem, ms; ic 98.65% $U^{236}$

E.H.Fleming, Jr., A.Ghiorso, B.B.Cunningham, Phys. Rev. 88, 642(1952).

**$_{92}U^{237}_{145}$**

| | | | |
|---|---|---|---|
| $\tau$ | | 6.75 d | $U^{236}$ (pile n) chem |
| $\beta^-$ | <20% | (0.080) | sl, scin $\beta\gamma$ |
| | >80% | 0.25 | |
| $\gamma$ | | 0.027 | |
| | | 0.043 | sl ce$^-$ |
| | 37† | 0.059 | |
| | | 0.165 | $K/L_1 < 0.2$ |
| | 21† | 0.207 | $K/L_1 = 4.8$ |
| | | 0.269 | |
| | 2.5† | 0.334 | |
| | | 0.370 | |
| | | 0.430 | |

$(0.21\gamma)(0.027\gamma)$ $(0.21\gamma)(0.06\gamma)$ $(0.21\gamma)(0.17\gamma)$ $(0.25\beta)(0.21\gamma)$

No $(0.33\gamma)(\gamma)$ No $0.51\beta$ (<0.1%)

No photon with $E_\gamma > 0.34$ (<10% of $0.33\gamma$)

F.Wagner, Jr., M.S.Freedman, D.W.Engelkemeir, J.R.Huizenga, Phys. Rev. 89, 502(1953).

**$_{92}U^{239}_{147}$**

$\gamma$ 0.074 $\alpha_L = 0.20$ $U^{239}$(pile n); pc

J.M.Kahn, ORNL-1089(1951).

**$_{92}U^{240}_{148}$**

$\tau$ 14.1 h $U^{238}(n,\gamma)U^{239}(n,\gamma)U^{240}$
$\beta^-$ 0.36 chem; sl
No $\gamma$ with $E_\gamma > 0.02$ scin

J.D.Knight, W.E.Bunker, B.Warren, J.W.Starner, Phys. Rev. 91, 889 (1953).

**$_{93}Np^{234}_{141}$**

$\gamma$ 0.177 $U^{235}$(14-Mev d) chem
0.442 s$\pi\sqrt{2}$ ce$^-$
0.803
1.42

G.D.O'Kelley, UCRL-1243(1951).

**$_{93}Np^{240}_{147}$**

| | | | |
|---|---|---|---|
| $\tau$ | | 7.3 m | d 14 h U chem |
| $\beta^-$ | 6% | 0.76 | sl |
| | 11% | 1.26 | |
| | 31% | 1.59 | |
| | 52% | 2.16 | |
| $\gamma$ | 63† | 0.56 | scin |
| | 26† | 0.90 | |
| | 10† | 1.40 | |

J.D.Knight, W.E.Bunker, B.Warren, J.W.Starner, Phys. Rev. 91, 889 (1953).

**$_{94}Pu^{238}_{144}$**

$\tau$ 89.6 y

A.H.Jaffey, J.Lerner, ANL-4411(1950).

| | | | |
|---|---|---|---|
| $\gamma$ | 6† | 0.013 | a |
| | 11† | 0.018 | |
| | 0.4† | 0.042 | |
| | | ~0.17 | |

†Photons per $10^2$ $\alpha$'s

G.W.Reed, Jr., AECD-3185(1947); NSA 5-5421(1951).

$\gamma$ 0.0450 pc

D.West, J.K.Dawson, C.J.Mandleberg, Phil. Mag. 43, 875(1952).

$\gamma$ 0.0451 s$\pi\sqrt{2}$ ce$^-$
vw 0.048 ?

Pu from long n irradiation of $Am^{241}$

G.D.O'Kelley, UCRL-1243(1951).

| | | | |
|---|---|---|---|
| $\alpha$ | 11% | 5.100 | s |
| | 20% | 5.137 | |
| | 69% | 5.150 | |

No other $\alpha$'s from 4.82 to 5.57 Mev (<0.3%)

F.Asaro, I.Perlman, Phys. Rev. 88, 828(1952).

**$_{94}Pu^{239}_{145}$**

| | | | |
|---|---|---|---|
| $\gamma$ | 2† | 0.0385 | pc |
| | 7† | 0.0520 | |

$(K\ x\ ray)/\alpha = \sim 2 \times 10^{-5}$ $(L\ x\ ray)/\alpha = 0.04$

†Photons per $10^5$ $\alpha$'s

D.West, J.K.Dawson, C.J.Mandleberg, Phil. Mag. 43, 875(1952).

| | | | |
|---|---|---|---|
| $\gamma$ | 40+ | 0.039 | pc |
| | 140+ | 0.053 | sl ce$^-$, pc |
| | 110+ | 0.100 | scin |
| | 50+ | 0.124 | scin |
| | 30+ | 0.384 | scin |

M.S.Freedman, F.Wagner, Jr., D.W.Engelkemeir, Phys. Rev. 88, 1155(1952).

U L x ray/$\alpha = 3 \times 10^{-2}$ pc

H.Israel, Phys. Rev. 88, 682(1952).

**$_{94}Pu^{240}_{146}$**

$\alpha$ 24% 5.118 Pu(pile n) ms; s
76% 5.162

F.Asaro, I.Perlman, Phys. Rev. 88, 828(1952).

$\gamma$ 0.050 $Pu^{239}$(pile n); sl ce$^-$

M.S.Freedman, F.Wagner, Jr., D.W.Engelkemeir, Phys. Rev. 88, 1155(1952).

**$_{94}Pu^{241}_{147}$**

$\tau_{\beta^-}$ 13.0 y

From $Am^{241}$ present 2.39 years after initial purification

D.R.MacKenzie, M.Lounsbury, A.W.Boyd, Phys. Rev. 90, 327(1953).

**$Pu^{241}$** 94 147

| | | | | |
|---|---|---|---|---|
| $\beta^-$ | | 0.0205 | $Pu^{240}$(pile n); sl | |
| $\gamma$ | $100^+$ | 0.100 | (K x ray?) | scin |
| | $20^+$ | 0.145 | | |

$^+$Photons per $10^7$ $\beta$'s

W.S.Freedman, F.Wagner, Jr., D.W.Engelkemeir, Phys. Rev. 88, 1155(1952).

**$Pu^{243}$** 94 149

| | | | | |
|---|---|---|---|---|
| $\tau$ | | $4.98^h$ | $Pu^{242}$(pile n) ion | chem |
| $\beta^-$ | 12% | (~0.37) | | |
| | 35% | 0.468 | | scin |
| | 53% | 0.57 | | |
| $\gamma$ | | 0.085 | $\alpha_L \leqslant 0.7$ | scin |
| | | ~0.1 | $\alpha_L > 10$ | |

(0.47$\beta$)(0.085$\gamma$) (0.085$\gamma$)(~0.1$\gamma$) (0.085$\gamma$)(L x rays)
No (0.57$\beta^-$) (0.085$\gamma$) No (0.57$\beta^-$) (L x rays)

D.W.Engelkemeir, P.R.Fields, J.R.Huizenga, Phys. Rev. 90, 6(1953).

**$Am^{241}$** 95 146

| | | | |
|---|---|---|---|
| I | | 5/2 | S |

Large q indicated

M.Fred, F.S.Thomkins, Phys. Rev. 89, 318(1953).

| | | | | |
|---|---|---|---|---|
| $\gamma$ | $25^+$ | 0.0264 | $Pu^{240}$(pile n,$\gamma\beta^-$); | pc |
| | | 0.041 | | sl ce$^-$ |
| | $100^+$ | 0.059 | | sl ce$^-$, pc |

W.S.Freedman, F.Wagner, Jr., D.W.Engelkemeir, Phys. Rev. 88, 1155(1952).

$\gamma$ 0.059 s$\pi$\2 ce$^-$
[$e^-_L$(0.059$\gamma$)]/$\alpha$ = 0.28

G.D.O'Kelley, UCRL-1243(1951).

$\gamma$ 0.0603 d $10^y$Pu; pc

D.West, J.K.Dawson, C.J.Mandleberg, Phil. Mag. 43, 875(1952).

No 0.0334$\gamma$, 0.0380$\gamma$ (< 0.1% of 0.0597$\gamma$) pc
Suggest lines seen* at 0.014, 0.019, 0.022 due to Am x rays, those at 0.033, 0.038 to La x rays

J.O.Newton, B.Rose, Phys. Rev. 89, 1157(1953).
*C.I.Browne, UCRL-1764(1952); F.Asaro, et al., Phys. Rev. 87, 277(1952).

**$Am^{242}$** 95 147 $16^h$

| | | | | | |
|---|---|---|---|---|---|
| $\beta^-$ | 70% | 0.628 | | | s$\pi$\2 |
| $\epsilon$ | 15% | | $Am^{241}$(pile n) | | chem |
| $\gamma$ IT | 15% | 0.035 | $\alpha$ = 0.25 | s$\pi$\2 | Am ce$^-$ |
| | | 0.038 | $\alpha$ = 0.25 | | Pu ce$^-$ |
| | | 0.053 | $\alpha$ = 0.67 | | Cm ce$^-$ |

$L_{III}/L_{II}$ x ray ratios: Am 4.9, Pu 1.3, Cm 1.0 cryst

No $\gamma$ with $E_\gamma > 0.06$ a

G.D.O'Kelley, UCRL-1243(1951).

$100^y$

| | | | |
|---|---|---|---|
| $\beta^-$ | 0.593 | $Am^{241}$(pile n) | chem |
| $\gamma$ | 0.038 | s$\pi$\2 | Pu ce$^-$ |
| | 0.053 | | Cm ce$^-$ |

G.D.O'Kelley, UCRL-1243(1951).

**$Cm^{242}$** 96 146

$\gamma$ 0.043 $\alpha_L$ = 0.8 s$\pi$\2 ce$^-$

G.D.O'Kelley, UCRL-1243(1951).

# NEUTRON CROSS SECTIONS

Absorption cross sections for neutron energies marked "th" (thermal) have been determined, from measurements in a thermal neutron flux, in terms of the cross section value of a "standard" for neutrons of velocity 2200 m/sec, or energy ~0.025 ev. The standard used is stated just after the reference and is generally one known to have a thermal absorption cross section with a 1/v energy dependence. If the nucleus whose cross section is being measured also has a cross section with 1/v dependence, the cross section found for it by comparison with the standard will, of course, be a cross section for 2200 m/sec. If not, and the dependence often is not known, the value found by the comparison is $\sigma v$ /2200.

| Reaction | $\sigma$ Type | Value | Energy | Ref. |
|---|---|---|---|---|
| H(n) | $\sigma_a$ | 0.332±0.007 | th | 53h8 |
| | $\sigma_a$ | 0.329±0.004 | th | 53h7 |
| | $\sigma_a$ | 0.321±0.005 | th | 53d7 |
| | $\sigma_t$ as f(T) for $H_2$ | | ~0.034 ev | 52g2 |
| | $\sigma_t$ | 4.23 | 1.001 | 53f4 |
| | $\sigma_t$ | 3.675±0.020 | 1.311 | 53f6 |
| | $\sigma_t$ | 2.525 | 2.532 | 53f2 |
| | $\sigma_t$ | graph | 3 - 13 | 53n1 |
| | $\sigma_t$ | 1.690 | 4.75 | 53h3 |
| | $\sigma_t$ | 0.686 | 14.1 | 52c1 |
| | $\sigma_t$ | 0.057 | 126 | 53t2 |
| | $\sigma_t$ | 0.074 - 0.0413 | 97 - 220 | 52m1 |
| | $\sigma_t$ | 0.037 | 390 | 53h1 |
| | $\sigma_t$ | 0.034 | 400 | 53n2 |
| $H^2$(n,n) | $\sigma_{el}$ | table | 0.135-0.914 | 53t4 |
| | $d\sigma_{el}/d\Omega$ | graphs | 0.135-0.914 | 53t4 |
| | $d\sigma_{el}/d\Omega$ | graphs | 0.2-2.5 | 53a2 |
| $H^2$(n) | $\sigma_t$ | graph | 0.2-3.0 | 53a2 |
| He(n,n) | $d\sigma_s/d\Omega$ | graph | 0.07 ev | 53h10 |
| He(n) | $\sigma_t$ | 0.8 | 0.07 ev | 53h10 |
| | $\sigma_t$ | 1.02 | 14.1 | 52c1 |
| | $\sigma_t$ | 0.200 | 84 | 53h2 |
| $Li^6$(n,t)$He^4$ | | 25 mb | 14 | 53f1 |
| $Li^6$(n,d)$He^5$ | | ~140 mb* | 14.2 | 52r1 |
| $Li^6$(n,d)$He^5$ g.s. | | 80 mb | 14 | 53f1 |
| $Li^6$(n,d')$He^5$ excited | | 81 mb | 14 | 53f1 |
| $Li^6$(n,p)$He^6$ | | 6 mb | 14 | 53f1 |
| $Li^6$(n,p) | $\sigma$($0.83^3$He) | 6.7 mb | 14 | 52b1 |
| $Li^6$(n) | $\sigma_t$ | 1.39 | 14.1 | 52c1 |

*Erroneously reported as ~14 mb, NSA 6, #20(1952).

**Neutron Cross Sections - continued**

| Reaction | σ Type | Value | Energy | Ref. |
|---|---|---|---|---|
| $Li^7(n,t)He^5$ | | 53 mb | 14 | 53f1 |
| $Li^7(n,d)$ | $\sigma(0.83^s He)$ | 9.8 mb | 14 | 52b1 |
| $Li^7(n)$ | $\sigma_t$ | 1.45 | 14.1 | 52c1 |
| Be(n) | $\sigma_t$ | 6.04 | 1ev-5kev | 52h5 |
| | $\sigma_t$ | graph | 3 - 13 | 53n1 |
| | $\sigma_t$ | 0.232 | 400 | 53n2 |
| $Be^9(n,\alpha)$ | $\sigma(0.83^s He)$ | 10 mb | 14 | 52b1 |
| $Be^9(n)$ | $\sigma_t$ | 1.53 | 14.1 | 52c1 |
| B(n) | $\sigma_s$ | 708 ± 12 | th | 53d7 |
| | $\sigma_a$ | 753 ± 3 | th | 53c10 |
| | Extrapolated value. $E_n$=0.025 to 0.00068 ev | | | |
| B(n,<11.5n) 82% $B^{10}$ | $\sigma_{in}$ | 0.69 | 14 | 52p2 |
| (n, <2.6n) | | 0.24 | | |
| $B^{10}(n)$ | $\sigma_t$ | 1.47 | 14.1 | 52c1 |
| $B^{11}(n)$ | $\sigma_t$ | 1.40 | 14.1 | 52c1 |
| C(n,<11.5n) | $\sigma_{in}$ | 0.76 | 14 | 52p2 |
| (n, <2.6n) | | 0.28 | | |
| C(n,n') | σ(all γ's) | 0.19 | 14 | 53s8 |
| C(n,n') | σ(~3-Mev γ's) | 0.2 | 14 | 53b5 |
| | σ(~5-Mev γ's) | 0.09 | 14 | 53b5 |
| C(n) | $\sigma_t$ | graph | 0.05-1 | 53k6 |
| | $\sigma_t$ | 2.21 | 1.32 | 53s1 |
| | $\sigma_t$ | graph | 2.2-2.8 | 53d4 |
| | $\sigma_t$ | graph | 3 - 13 | 53n1 |
| | $\sigma_t$ | 1.32 | 14.1 | 52c1 |
| | $\sigma_t$ | graph | 30-139 | 53t2 |
| | $\sigma_t$ | 0.502 - 0.297 | 97 - 220 | 52m1 |
| | $\sigma_t$ | 0.287 | 390 | 53h1 |
| | $\sigma_t$ | 0.298 | 400 | 53n2 |
| | σ(spallation) | | 90 | 53k5 |
| $C^{12}(n,2n)$ | $\sigma(20^m C)$ | graph | 24 - 27 | 52b1 |
| $C^{13}(n,\gamma)$ | $\sigma(5700^y C)$ | ≤0.01 | th | 53b11 |
| N(n,<11.5n) | $\sigma_{in}$ | 0.79 | 14 | 52p2 |
| (n, <2.6n) | | 0.46 | | |
| (n) | $\sigma_t$ | graph | 1.7 - 4 | 52j2 |
| | $\sigma_t$ | graph | 1.9-3.8 | 53m9 |
| | $\sigma_t$ | 1.59 | 14.1 | 52c1 |
| $N^{14}(n,t)$ | $\bar{\sigma}(t)$ | 11 ± 2 mb | fission n's thresh =4.4 | 53f8 |
| $N^{14}(n,2n)$ | $\sigma(10^m N)$ | 5.7 mb | 14.5 | 53p1 |

**Neutron Cross Sections - continued**

| Reaction | σ Type | Value | Energy | Ref. |
|---|---|---|---|---|
| O(n) | $\sigma_{el}$ | 0.7 | 14.1 | 53c3 |
| O(n,<14.1n) | $\sigma_{in}$ | 0.5 | 14.1 | 53c3 |
| O(n,n') | σ(~7-Mev γ's) | 0.14 | 14 | 53b5 |
| | σ(all γ's) | 0.52 | 14 | 53s8 |
| O(n) | $\sigma_t$ | graph | 3 - 13 | 53n1 |
| | $\sigma_t$ | 1.6 | 14.1 | 53c3 |
| | $\sigma_t$ | 1.58 | 14.1 | 52c1 |
| | $\sigma_t$ | 1.68 | 14 | 53a1 |
| | $\sigma_t$ | 0.379 | 400 | 53n2 |
| $O^{16}(n,p)$ | $\sigma(7.3^s N)$ | 49 mb | 14.5 | 53p1 |
| F(n) | $\sigma_t$ | 1.70 | 14.1 | 52c1 |
| $F^{19}(n,2n)$ | $\sigma(1.9^h F)$ | 61 mb | 14.5 | 53p1 |
| $F^{19}(n,p)$ | $\sigma(30^s O)$ | 130 mb | 14.5 | 53p1 |
| Na(n) | $\sigma_t$ | 2.98 | 1ev-1kev | 52h5 |
| | $\sigma_t$ | graph | 1ev-10kev | 52h5 |
| | $\sigma_t$ | graph | 1.9-3.8 | 53m7 |
| | $\sigma_t$ | graph | 2.3-2.8 | 53d4 |
| | $\sigma_t$ | 1.71 | 14.1 | 52c1 |
| | $\sigma_t$ | graph | 0.12 - 1 | 52s1 |
| $Na^{23}(n,p)$ | $\sigma(40^s Ne)$ | 34 mb | 14.5 | 53p1 |
| $Na^{23}(n,\gamma)$ | $\sigma(15.0^h Na)$ | 0.53 | th | 53b2 |
| | $\sigma(15.0^h Na)$ | 0.26 mb | ~1 | 53h11 |
| Mg(n,n) | $\sigma_s$ free | 3.51 | 0.5-1000 ev | 53e8 |
| Mg(n) | $\sigma_t$ | 1.75 | 14.1 | 52c1 |
| $Mg^{24}(n,p)$ | $\sigma(15.0^h Na)$ | 190 mb | 14.5 | 53p1 |
| $Mg^{25}(n,p)$ | $\sigma(62^s Na)$ | 45 mb | 14.5 | 53p1 |
| $Mg^{26}(n,\gamma)$ | $\sigma(9.6^m Mg)$ | 0.6 mb | ~1 | 53h11 |
| Al(n,n) | $d\sigma_s/d\Omega$ | graph | 3.7 | 53w7 |
| Al(n,<11.5n) | $\sigma_{in}$ | 1.06 | 14 | 52p2 |
| (n, <2.6n) | | 0.62 | | |
| Al(n,n') | σ(~2-Mev γ's) | ~2 | 14 | 53b5 |
| | σ(~6-Mev γ's) | ~0.3 | 14 | 53b5 |
| | σ(all γ's) | 1.7 | 14 | 53s8 |
| Al(n) | $\sigma_t$ | 1.64 | th | 53w6 |
| | $\sigma_t$ | 1.38 | 5ev - 5kev | 52m4 |
| | $\sigma_t$ | graph | 1.9-3.8 | 53n9 |
| | $\sigma_t$ | 2.55 | 3.7 | 53w7 |
| | $\sigma_t$ | graph | 3 - 13 | 53n1 |
| | $\sigma_t$ | 1.73 | 14.1 | 52c1 |
| | $\sigma_t$ | 1.86 | 14 | 53a1 |
| | $\sigma_t$ | graph | 30-139 | 53t2 |
| | $\sigma_t$ | 0.588 | 400 | 53n2 |
| $Al^{27}(n,\alpha)$ | $\sigma(15.0^h Na)$ | 79 mb | 14.5 | 53p1 |
| | $\sigma(15.0^h Na)$ | 135 mb | 14.1 | 52f1 |
| $Al^{27}(n,p)$ | $\sigma(9.5^m Mg)$ | 52 mb | 14.5 | 53p1 |

Neutron Cross Sections - continued

| Reaction | σ Type | Value | Energy | Ref. |
|---|---|---|---|---|
| $Al^{27}(n,p)$ | $\sigma(9.5^{m}Mg)$ | 79 mb | 14.1 | 52f1 |
| $Al^{27}(n,\gamma)$ | $\sigma(2.3^{m}Al)$ | 0.37 mb | ~1 | 53h11 |
| Si(n) | $\sigma_t$ | graph | 1.9-3.8 | 53m9 |
| | $\sigma_t$ | graph | 3 - 13 | 53n1 |
| | $\sigma_t$ | 1.86 | 14.1 | 52c1 |
| $Si^{28}(n,p)$ | $\sigma(2.4^{m}Al)$ | 220 mb | 14.5 | 53p1 |
| $Si^{29}(n,p)$ | $\sigma(6.6^{m}Al)$ | 100 mb | 14.5 | 53p1 |
| $Si^{30}(n,\alpha)$ | $\sigma(9.5^{m}Mg)$ | 46 mb | 14.5 | 53p1 |
| $Si^{30}(n,\gamma)$ | $\sigma(2.6^{h}Si)$ | 1.1 mb | ~1 | 53h11 |
| P(n) | $\sigma_t$ | graph | 0.1-0.7 | 53s4 |
| | $\sigma_t$ | 1.97 | 14.1 | 52c1 |
| | $\sigma_t$ | 2.22 | 14 | 53a1 |
| $P^{31}(n,\alpha)$ | $\sigma(2.4^{m}Al)$ | 0.15 | 14.5 | 53p1 |
| $P^{31}(n,p)$ | $\sigma(2.6^{h}Si)$ | 0.064 | 14.5 | 53p1 |
| | $\sigma(2.6^{h}Si)$ | 0.091 | 14.1 | 52f1 |
| S(n) | $\sigma_t$ | graph | 3 - 13 | 53n1 |
| | $\sigma_t$ | 2.06 | 14 | 53a1 |
| | $\sigma_t$ | 1.92 | 14.1 | 52c1 |
| | $\sigma_t$ | 0.681 | 400 | 53n2 |
| $S^{32}(n,p)$ | $\sigma(14.3^{d}P)$ | 0.37 | 14.5 | 53p1 |
| $S^{33}(n,p)$ | $\sigma(25^{d}P)$ | 0.0023 | th | 52W1 |
| $S^{34}(n,\alpha)$ | $\sigma(26^{h}Si)$ | 0.14 | 14.5 | 53p1 |
| $S^{34}(n,p)$ | $\sigma(12.4^{s}P)$ | 0.085 | 14.5 | 53p1 |
| Cl(n) | $\sigma_t$ | graph | 0.1-0.7 | 53s4 |
| | $\sigma_t$ | graph | 0.15-1 | 53k6 |
| | $\sigma_t$ | graph | 2.2-2.8 | 53d4 |
| | $\sigma_t$ | 2.00 | 14.1 | 52c1 |
| | $\sigma_t$ | 0.743 | 400 | 53n2 |
| $Cl^{35}(n,\alpha)$ | $\sigma(\alpha)$ | graph | 3-4 | 53a4 |
| $Cl^{35}(n,\alpha)$ | $\sigma(14.3^{d}P)$ | 0.19 | 14.5 | 53p1 |
| $Cl^{35}(n,2n)$ | $\sigma(33^{m}Cl)$ | 0.0035 | 14.5 | 53p1 |
| $Cl^{37}(n,\alpha)$ | $\sigma(12.4^{s}P)$ | 0.052 | 14.5 | 53p1 |
| $Cl^{37}(n,p)$ | $\sigma(5.0^{m}S)$ | 0.033 | 14.5 | 53p1 |
| $Cl^{37}(n,\gamma)$ | $\sigma(38^{m}Cl)$ | 0.74 mb | ~1 | 53h11 |
| $A^{36}(n,\alpha)$ | $\sigma(\alpha_o)$* | table | 2.1-4.4 | 53t5 |
| | $\sigma(\alpha_1)$* | table | 2.1-4.4 | 53t5 |
| * $\alpha_o$ to g.s. $S^{33}$; $\alpha_1$ to 1.1-Mev level $S^{33}$ | | | | |
| A(n) | $\sigma_t$ | graph | 0.4-1.1 | 53g4 |
| $A^{40}(n,\gamma)$ | $\sigma(1.8^{h}A)$ | 0.93 mb | ~1 | 53h11 |
| K(n) | $\sigma_t$ | 2.24 | 14.1 | 52c1 |
| $K^{39}(n)$ | $\sigma_a$ | 1.9 | th | 52p1 |
| $K^{39}(n,2n)$ | $\sigma(7.5^{m}K)$ | 0.010 | 14.5 | 53p1 |
| $K^{40}(n)$ | $\sigma_a$ | ~ 65 | th | 52p1 |
| $K^{41}(n)$ | $\sigma_a$ | 1.2 | th | 52p1 |

Neutron Cross Sections - continued

| Reaction | σ Type | Value | Energy | Ref. |
|---|---|---|---|---|
| $K^{41}(n,\alpha)$ | $\sigma(38^{m}Cl)$ | 0.031 | 14.5 | 53p1 |
| $K^{41}(n,p)$ | $\sigma(1.8^{h}A)$ | 0.081 | 14.5 | 53p1 |
| $K^{41}(n,\gamma)$ | $\sigma(12.4^{h}K)$ | 2.9 mb | ~1 | 53h11 |
| Ca(n) | $\sigma_t$ | 2.19 | 14.1 | 52c1 |
| $Ca^{46}(n,\gamma)$ | $\sigma(3.4^{d}Sc)$ | 0.25 | th | 53c6 |
| $Ca^{48}(n,\gamma)$ | $\sigma(8.5^{m}Ca)$ | 1.9 mb | ~1 | 53h11 |
| Sc(n) | $\sigma_a$ | 23 | th | 53l1 |
| | $\sigma_a$ | 23 | th | 52p3 |
| Sc(n,n) | $\sigma_s$ coh | 18 | | 53m7 |
| Sc(n) | $\sigma_t$ | 24 | | 53m7 |
| $Sc^{45}(n,\gamma)$ | $\sigma(85^{d}Sc)$ | 22 | th | 53l2 |
| Ti(n) | $\sigma_t$ | graph | 2.2-2.8 | 53d4 |
| | $\sigma_t$ | 2.28 | 14.1 | 52c1 |
| $Ti^{48}(n,p)$ | $\sigma(1.8^{d}Sc)$ | 0.093 | 14.5 | 53p1 |
| $Ti^{50}(n,\gamma)$ | $\sigma(6^{m}Ti)$ | 1.9 mb | ~1 | 53h11 |
| V(n) | $\sigma_t$ | graph | 0.02 - 5ev | 53b4 |
| $V^{51}(n,\alpha)$ | $\sigma(1.8^{d}Sc)$ | 0.029 | 14.5 | 53p1 |
| $V^{51}(n,p)$ | $\sigma(6^{m}Ti)$ | 0.027 | 14.5 | 53p1 |
| $V^{51}(n,\gamma)$ | $\sigma(3.7^{m}V)$ | 1.8 mb | ~1 | 53h11 |
| Cr(n) | $\sigma_t$ | 2.45 | 14.1 | 52c1 |
| $Cr^{52}(n,p)$ | $\sigma(3.7^{m}V)$ | 0.078 | 14.5 | 53p1 |
| Mn(n,γ) | $\sigma(2.6^{h}Mn)$ | 12.0 | th | 52b2 |
| Mn(n) | $\sigma_t$ | 2.54 | 14.1 | 52c1 |
| $Mn^{55}(n,\alpha)$ | $\sigma(3.7^{m}V)$ | 0.052 | 14.5 | 53p1 |
| $Mn^{55}(n,\gamma)$ | $\sigma(2.6^{h}Mn)$ | 12.7 | th | 53b2 |
| | $\sigma(2.6^{h}Mn)$ | 3.82 mb | ~1 | 53h11 |
| Fe(n,n) | $\sigma_s$ incoh | 0.43 | | 53g5 |
| | $\sigma_s$ free | 11.39 | | 53g5 |
| | $\sigma_{el}$ | 2.0 | 1.0 | 53w3 |
| | $d\sigma_{el}/d\Omega$ | graph | 1.0 | 53w3 |
| | $d\sigma_s/d\Omega$ | graph | 3.7 | 53w7 |
| Fe(n,<11.5n) | $\sigma_{in}$ | 1.45 | 14 | 52p2 |
| (n, <2.6n) | | 1.21 | | |
| (n, <1.4n) | | 0.78 | | |
| Fe(n,n') | σ(all γ's) | 4.6 | 14 | 53s2 |
| | σ(~6.5Mev γ's) | ~0.5 | 14 | 53b5 |
| | σ(~2.5Mev γ's) | ~2.4 | 14 | 53b5 |
| Fe(n) | $\sigma_t$ | 2.60 | 14.1 | 52c1 |
| | $\sigma_t$ | graph | 1 - 3.2 | 52m2 |
| | $\sigma_t$ | 3.51 | 3.7 | 53w7 |
| | $\sigma_t$ | graph | 3 - 13 | 53n1 |
| | $\sigma_t$ | 1.07 | 400 | 53n2 |
| $Fe^{56}(n,p)$ | $\sigma(2.6^{h}Mn)$ | 0.124 | 14.1 | 52f1 |
| | $\sigma(2.6^{h}Mn)$ | 0.097 | 14.5 | 53p1 |
| $Fe^{56}(n,n')$ | $\sigma(0.85\gamma)$ | ~0.4 | 1.23 | 53r1 |

Neutron Cross Sections - continued

| Reaction | σ Type | Value | Energy | Ref. |
|---|---|---|---|---|
| Co(n) | $\sigma_t$ | graph | 1ev - 5kev | 52m4 |
| | $\sigma_t$ | graph | 0.1 - 3 | 53w2 |
| | $\sigma_t$ | 2.72 | 14.1 | 52c1 |
| $Co^{59}(n,\alpha)$ | $\sigma(2.6^h Mn)$ | 0.039 | 14.5 | 53p1 |
| $Co^{59}(n,\gamma)$ | $\sigma(10.7^m Co)$ | 19 | th | 53m8 |
| | $\sigma(10.7^m Co)$ | <0.008 | ~0.025 | 53k4 |
| | $\sigma(10.7^m Co)$ | 4.6 mb | ~1 | 53h11 |
| $10.7^m Co^{60}(n,\gamma)$ | $\sigma(1.7^h Co)$ | ~90 | pile | 53f15 |
| $5.2^y Co^{60}(n,\gamma)$ | $\sigma(1.7^h Co)$ | ~6 | pile | 53f15 |
| Ni(n,n) | $\sigma_s$ coh | 12.9 | | 53g5 |
| | $\sigma_s$ free | 17.43 | | 53g5 |
| | $\sigma_{el}$ | 2.8 | 1.0 | 53w3 |
| | $d\sigma_{el}/d\Omega$ | graph | 1.0 | 53w3 |
| Ni(n,n') | σ(all γ's) | 6 | 14 | 53s8 |
| Ni(n) | $\sigma_t$ | graph | 5ev - 5kev | 52m4 |
| | $\sigma_t$ | 2.67 | 14.1 | 52c1 |
| | $\sigma_t$ | graph | 1 - 3.2 | 52m2 |
| $Ni^{58}(n)$ | $\sigma_a$ | 4.2 | th | 52p1 |
| $Ni^{58}(n,2n)$ | $\sigma(36^h Ni)$ | 0.041 | 14.5 | 53p1 |
| $Ni^{60}(n)$ | $\sigma_a$ | 2.5 | th | 52p1 |
| $Ni^{61}(n)$ | $\sigma_a$ | 2 | th | 52p1 |
| $Ni^{61}(n,p)$ | $\sigma(1.7^h Co)$ | 0.18 | 14.5 | 53p1 |
| $Ni^{62}(n)$ | $\sigma_a$ | 15 | th | 52p1 |
| $Ni^{64}(n,\gamma)$ | $\sigma(2.6^h Ni)$ | 5.1 mb | ~1 | 53h11 |
| Cu(n,n) | $\sigma_{el}$ | 2.9 | 1.0 | 53w3 |
| | $d\sigma_{el}/d\Omega$ | graph | 1.0 | 53w3 |
| Cu(n,<11.5n) | $\sigma_{in}$ | 1.51 | 14 | 52p2 |
| (n,<2.6n) | | 1.32 | | |
| (n,<1.4n) | | 0.87 | | |
| Cu(n,n') | σ(all γ's) | 6.3 | 14 | 53s8 |
| Cu(n) | $\sigma_t$ | graph | 1 - 3.2 | 52m2 |
| | $\sigma_t$ | graph | 3 - 13 | 53n1 |
| | $\sigma_t$ | 2.5 | 14 | 52g1 |
| | $\sigma_t$ | 2.96 | 14.1 | 52c1 |
| | $\sigma_t$ | 3.09 | 14 | 53a1 |
| | $\sigma_t$ | table | 30 - 153 | 53t2 |
| | $\sigma_t$ | 1.19 | 400 | 53n2 |
| $Cu^{63}(n,2n)$ | $\sigma(10^m Cu)$ | 0.510 | 14.1 | 52f1 |
| | $\sigma(10^m Cu)$ | 0.48 | 14.5 | 53p1 |
| | $\sigma(10^m Cu)$ | graph | 12 - 27 | 52b2 |
| | $\sigma(10^m Cu)$ | graph | 13 - 27 | 53b6 |
| $Cu^{63}(n,\gamma)$ | $\sigma(12.9^h Cu)$ | 0.12 | ~0.025 | 53k4 |
| | $\sigma(12.9^h Cu)$ | 11.4 mb | ~1 | 53h11 |
| $Cu^{65}(n,2n)$ | $\sigma(12.9^h Cu)$ | 0.970 | 14.1 | 52f1 |
| $Cu^{65}(n,2n)$ | $\sigma(12.9^h Cu)$ | 1.10 | 14.5 | 53p1 |
| $Cu^{65}(n,p)$ | $\sigma(2.56^h Ni)$ | 0.019 | 14.1 | 52f1 |
| $Cu^{65}(n,\gamma)$ | $\sigma(5.1^h Cu)$ | 6.0 mb | ~1 | 53h11 |
| Zn(n) | $\sigma_{el}$ | 3.3 | 1.0 | 53w3 |
| | $d\sigma_{el}/d\Omega$ | graph | 1.0 | 53w3 |

Neutron Cross Sections - continued

| Reaction | σ Type | Value | Energy | Ref. |
|---|---|---|---|---|
| Zn(n) | $\sigma_t$ | 3.06 | 14.1 | 52c1 |
| | $\sigma_t$ | graph | 1 - 3.2 | 52m2 |
| $Zn^{64}(n,2n)$ | $\sigma(38^m Zn)$ | 0.22 | 14.5 | 53p1 |
| $Zn^{64}(n,p)$ | $\sigma(12.9^h Cu)$ | 0.39 | 14.5 | 53p1 |
| $Zn^{66}(n,p)$ | $\sigma(5^m Cu)$ | 0.10 | 14.5 | 53p1 |
| $Zn^{68}(n,\gamma)$ | $\sigma(14^h Zn)$ | 15.2 mb | ~1 | 53h11 |
| | $\sigma(52^m Zn)$ | 8.0 mb | ~1 | 53h11 |
| Ga(n) | $\sigma_t$ | graph | 5ev - 5kev | 52m4 |
| | $\sigma_t$ | 3.19 | 14.1 | 52c1 |
| | $\sigma_t$ | graph | 0.1 - 3 | 53w2 |
| $Ga^{69}(n)$ | $\sigma_a$ | 2.0 | th | 52p1 |
| $Ga^{69}(n,\alpha)$ | $\sigma(5^m Cu)$ | 0.10 | 14.5 | 53p1 |
| $Ga^{69}(n,2n)$ | $\sigma(68^m Ga)$ | 0.55 | 14.5 | 53p1 |
| $Ga^{69}(n,p)$ | $\sigma(14^h Zn)$ | 0.024 | 14.5 | 53p1 |
| $Ga^{69}(n,\gamma)$ | $\sigma(20^m Ga)$ | 20.9 mb | ~1 | 53h11 |
| $Ga^{71}(n)$ | $\sigma_a$ | 4.9 | th | 52p1 |
| $Ga^{71}(n,2n)$ | $\sigma(20^m Ga)$ | 0.70 | 14.5 | 53p1 |
| Ge(n) | $\sigma_t$ | graph | 0.4 - 3.5 | 52j2 |
| $Ge^{70}(n,2n)$ | $\sigma(40^h Ge)$ | 0.67 | 14.5 | 53p1 |
| $Ge^{70}(n,p)$ | $\sigma(20^m Ga)$ | 0.13 | 14.5 | 53p1 |
| $Ge^{72}(n,p)$ | $\sigma(14^h Ga)$ | 0.065 | 14.5 | 53p1 |
| $Ge^{73}(n,p)$ | $\sigma(5.0^h Ga)$ | 0.14 | 14.5 | 53p1 |
| $Ge^{74}(n,\alpha)$ | $\sigma(2.2^m Zn)$ | 0.015 | 14.5 | 53p1 |
| $Ge^{74}(n,\gamma)$ | $\sigma(82^m Ge)$ | 0.038 | ~0.025 | 53k4 |
| | $\sigma(82^m Ge)$ | 12 mb | ~1 | 53h11 |
| $Ge^{76}(n,2n)$ | $\sigma(82^m Ge)$ | 1.80 | 14.5 | 53p1 |
| $As^{75}(n,\alpha)$ | $\sigma(14^h Ga)$ | 0.012 | 14.5 | 53p1 |
| $As^{75}(n,2n)$ | $\sigma(17^d As)$ | 0.54 | 14.5 | 53p1 |
| $As^{75}(n,p)$ | $\sigma(82^m Ge)$ | 0.012 | 14.5 | 53p1 |
| $As^{75}(n,\gamma)$ | $\sigma(27^h As)$ | 22.5 mb | ~1 | 53h11 |
| Se(n) | $\sigma_t$ | graph | 0.4 - 3.5 | 52j2 |
| | $\sigma_t$ | graph | 0.1 - 3 | 53w2 |
| | $\sigma_t$ | 3.56 | 14.1 | 52c1 |
| $Se^{74}(n)$ | $\sigma_a$ | 50 | th | 52p1 |
| $Se^{76}(n)$ | $\sigma_a$ | 82 | th | 52p1 |
| $Se^{77}(n)$ | $\sigma_a$ | 40 | th | 52p1 |
| $Se^{77}(n,p)$ | $\sigma(40^h As)$ | 0.045 | 14.5 | 53p1 |
| $Se^{78}(n)$ | $\sigma_a$ | 0.4 | th | 52p1 |
| $Se^{80}(n)$ | $\sigma_a$ | 0.59 | th | 52p1 |
| $Se^{80}(n,\alpha)$ | $\sigma(59^s Ge)$ | 0.038 | 14.5 | 53p1 |
| $Se^{82}(n)$ | $\sigma_a$ | 2 | th | 52p1 |
| $Se^{82}(n,2n)$ | $\sigma(58^m Se)$ | 1.5 | 14.5 | 53p1 |
| Br(n) | $\sigma_t$ | graph | 2.2-2.8 | 53d4 |
| | $\sigma_t$ | 3.52 | 14.1 | 52c1 |
| $Br^{79}(n,2n)$ | $\sigma(6.4^m Br)$ | 1.10 | 14.5 | 53p1 |
| $Br^{79}(n,\gamma)$ | $\sigma(4.4^h Br)$ | 13.5 mb | ~1 | 53h11 |
| | $\sigma(18.5^m Br)$ | 29 mb | ~1 | 53h11 |
| $Br^{81}(n,\alpha)$ | $\sigma(90^m As)$ | 0.10 | 14.5 | 53p1 |
| $Br^{81}(n,2n)$ | $\sigma(4.4^h Br$ | 0.83 | 14.5 | 53p1 |

Neutron Cross Sections - continued

| Reaction | σ Type | Value | | Energy | Ref. |
|---|---|---|---|---|---|
| $Br^{81}(n,\gamma)$ | $\sigma(36^{h}Br)$ | 17 | mb | ~1 | 53h11 |
| $Kr^{78}(n)$ | $\sigma(34^{h}Kr)$ | 1.6 | | th | 52b5 |
| $Kr^{84}(n,\gamma)$ | $\sigma(4.4^{h}Kr)$ | 1.9 | mb | ~1 | 53h11 |
| | $\sigma(10^{y}Kr)$ | <8 | mb | ~1 | 53h11 |
| $Kr^{86}(n,\gamma)$ | $\sigma(78^{m}Kr)$ | 2.4 | mb | ~1 | 53h11 |
| $Rb^{85}(n,\gamma)$ | $\sigma(19^{d}Rb)$ | 23.1 | mb | ~1 | 53h11 |
| $Rb^{87}(n,\alpha)$ | $\sigma(33^{m}Br)$ | 0.039 | | 14.5 | 53p1 |
| $Rb^{87}(n,\gamma)$ | $\sigma(17.8^{m}Rb)$ | 1.8 | mb | ~1 | 53h11 |
| Sr(n) | $\sigma_t$ | graph | | 0.05 - 3.2 | 52m2 |
| | $\sigma_t$ | 3.68 | | 14.1 | 52c1 |
| $Sr^{84}(n,\gamma)$ | $\sigma(65^{d}Sr)$ | 0.32 | | th | 52h2 |
| | $\sigma(65^{d}Sr)$ | 1.2 | | th | 53i2 |
| $Sr^{88}(n,\alpha)$ | $\sigma(4.4^{h}Kr)$ | 0.064 | | 14.5 | 53p1 |
| $Sr^{88}(n,p)$ | $\sigma(17.8^{m}Rb)$ | 0.018 | | 14.5 | 53p1 |
| $Sr^{88}(n,\gamma)$ | $\sigma(53^{d}Sr)$ | 2.1 | mb | ~1 | 53h11 |
| Y(n) | $\sigma_t$ | graph | | 0.05 - 3.2 | 52m2 |
| | $\sigma_t$ | 3.88 | | 14.1 | 52c1 |
| $Y^{89}(n,\alpha)$ | $\sigma(19^{d}Rb)$ | 0.070 | | 14.5 | 53p1 |
| $Y^{89}(n,\gamma)$ | $\sigma(61^{h}Y)$ | 7.0 | mb | ~1 | 53h11 |
| Zr(n) | $\sigma_t$ | graph | | 1 - 3.2 | 52m2 |
| | $\sigma_t$ | graph | | 3 - 13 | 53n1 |
| | $\sigma_t$ | 3.6 | | 14 | 52g1 |
| | $\sigma$ | 4.00 | | 14.1 | 52c1 |
| $Zr^{90}(n,\alpha)$ | $\sigma(2.8^{h}Sr)$ | 0.2 | | 14.5 | 53p1 |
| $Zr^{90}(n,2n)$ | $\sigma(4.5^{m}Zr)$ | 0.08 | | 14.5 | 53p1 |
| $Zr^{90}(n,p)$ | $\sigma(61^{h}Y)$ | 0.25 | | 14.5 | 53p1 |
| $Zr^{94}(n,p)$ | $\sigma(18^{m}Y)$ | 0.01 | | 14.5 | 53p1 |
| Nb(n) | $\sigma_t$ | graph | | 0.12 - 3.2 | 52m2 |
| | $\sigma_t$ | 4.02 | | 14.1 | 52c1 |
| $Nb^{93}(n,\gamma)$ | $\sigma(6.6^{m}Nb)$ | 41 | mb | ~1 | 53h11 |
| $Nb^{94}(n,\gamma)$ | $\sigma(35^{d}Nb)$ | ~15 | | pile | 53d2 |
| Mo(n) | $\sigma_t$ | graph | | 1ev - 10kev | 52h5 |
| | $\sigma_t$ | graph | | 0.02 - 3.2 | 52m2 |
| | $\sigma_t$ | 4.04 | | 14.1 | 52c1 |
| $Mo^{92}(n)$ | $\sigma_a$ | ≤0.3 | | th | 52p1 |
| $Mo^{92}(n,2n)$ | $\sigma(15.5^{m}Mo)$ | graph | | 13.2 - 27 | 52b2 |
| | $\sigma(15.5^{m}+75^{s}Mo)$ | 0.19 | | 14.5 | 53p1 |
| | $\sigma(15.5^{m}Mo)$ | graph | | 13 - 27 | 53b6 |
| $Mo^{97}(n,p)$ | $\sigma(78^{m}Nb)$ | 0.1 | | 14.5 | 53p1 |
| $Mo^{98}(n,\gamma)$ | $\sigma(68^{h}Mo)$ | 10.4 | mb | ~1 | 53h11 |
| $Mo^{100}(n,2n)$ | $\sigma(68^{h}Mo)$ | 3.8 | | 14.5 | 53p1 |

Neutron Cross Sections - continued

| Reaction | σ Type | Value | | Energy | Ref. |
|---|---|---|---|---|---|
| $Mo^{100}(n,\gamma)$ | $\sigma(15.5^{m}Mo)$ | 12.3 | mb | ~1 | 53h11 |
| $Ru^{96}(n,2n)$ | $\sigma(1.6^{h}Ru)$ | 0.48 | | 14.5 | 53p1 |
| $Ru^{101}(n,p)$ | $\sigma(15^{m}Tc)$ | 0.002 | | 14.5 | 53p1 |
| $Ru^{102}(n,\gamma)$ | $\sigma(42^{d}Ru)$ | 30 | mb | ~1 | 53h11 |
| $Ru^{104}(n,\gamma)$ | $\sigma(4.4^{h}Ru)$ | 31 | mb | ~1 | 53h11 |
| Rh(n) | $\sigma_a$ | 4.1 | | 0.15 ev | 53b4 |
| | $\sigma_a$ free | 5.5 | | 1.26 ev | 53s7 |
| $Rh^{103}(n,\gamma)$ | $\sigma(4.3^{m}Rh)$ | 15.4 | mb | ~1 | 53h11 |
| | $\sigma(44^{s}Rh)$ | 94 | mb | ~1 | 53h11 |
| $Pd^{102}(n,\gamma)$ | $\sigma(17^{d}Pd)$ | 4.8 | | pile | 53m5 |
| $Pd^{104}(n,p)$ | $\sigma(4.3^{m}+44^{s}Rh)$ | 0.13 | | 14.5 | 53p1 |
| $Pd^{105}(n,p)$ | $\sigma(36^{h}Rh)$ | 0.7 | | 14.5 | 53p1 |
| $Pd^{108}(n,\gamma)$ | $\sigma(13^{h}Pd)$ | 108 | mb | ~1 | 53h11 |
| $Pd^{110}(n,\alpha)$ | $\sigma(4^{m}Ru)$ | 0.014 | | 14.5 | 53p1 |
| $Pd^{110}(n,2n)$ | $\sigma(13^{h}Pd)$ | 1.9 | | 14.5 | 53p1 |
| Ag(n,n) | $\sigma_{el}$ | 4.2 | | 1.0 | 53w3 |
| | $d\sigma_{el}/d\Omega$ | graph | | 1.0 | 53w3 |
| Ag(n) | $\sigma_t$ | graph | | 12ev - 5kev | 52m4 |
| | $\sigma_t$ | graph | | 1 - 3.2 | 52m2 |
| | $\sigma_t$ | 4.34 | | 14.1 | 52c1 |
| $Ag^{107}(n,2n)$ | $\sigma(24.5^{m}Ag)$ | 0.56 | | 14.1 | 52f1 |
| | $\sigma(24.5^{m}Ag)$ | 0.5 | | 14.5 | 53p1 |
| $Ag^{107}(n,\gamma)$ | $\sigma(2.3^{m}Ag)$ | 85 | mb | ~1 | 53h11 |
| $Ag^{109}(n,2n)$ | $\sigma(2.3^{m}Ag)$ | 1.0 | | 14.1 | 52f1 |
| | $\sigma(2.3^{m}Ag)$ | 0.3 | | 14.5 | 53p1 |
| $Ag^{109}(n,\gamma)$ | $\sigma(24.5^{s}Ag)$ | 174 | mb | ~1 | 53h11 |
| Cd(n,n) | $\sigma_{el}$ | 5.2 | | 1.0 | 53w3 |
| | $d\sigma_{el}/d\Omega$ | graph | | 1.0 | 53w3 |
| Cd(n,n') | $\sigma(49^{m}Cd)$ | 0.21 | | 1.27 | 53f3 |
| | | graph | | 0.4 - 1.3 | 53f3 |
| Cd(n,<11.5n) | $\sigma_{in}$ | 1.89 | | 14 | 52p2 |
| (n,<2.6n) | | 1.66 | | | |
| (n,<1.4n) | | 1.14 | | | |
| Cd(n,n') | $\sigma$(all $\gamma$'s) | 12.8 | | ~1 | 53s8 |
| Cd(n) | $\sigma_s/\sigma_a$ | graph | | 0.025 - 0.4 ev | 53b4 |
| | $\sigma_t$ | 7800 | | 0.175 ev | 53b4 |
| | $\sigma_t$ | graph | | 0.1 - 3 | 53w2 |
| | $\sigma_t$ | graph | | 0.4 - 3.5 | 52j2 |
| | $\sigma_t$ | 4.44 | | 14.1 | 52c1 |
| | $\sigma_t$ | table | | 37 - 153 | 53t2 |
| | $\sigma_t$ | 1.84 | | 400 | 53n2 |
| $Cd^{110}(n,\gamma)$ | $\sigma(49^{m}Cd)$ | <0.001 | | 0.2 - 0.4 | 53f3 |
| In(n,n) | $\sigma_{el}$ | 6.1 | | 1.0 | 53w3 |
| | $d\sigma_{el}/d\Omega$ | graph | | 1.0 | 53w3 |

Neutron Cross Sections - continued

| Reaction | $\sigma$ Type | Value | | Energy | Ref. |
|---|---|---|---|---|---|
| In(n) | $\sigma_t$ | graph | | 1 - 3.2 | 52m2 |
| | $\sigma_t$ | 4.53 | | 14.1 | 52c1 |
| $In^{115}(n,\gamma)$ | $\sigma(54^m In)$ | 166 | mb | ~1 | 53h11 |
| | $\sigma(13^s In)$ | 57 | mb | ~1 | 53h11 |
| $In^{115}(n,n')$ | $\sigma(4.5^h In)$ | graph | | 0.44-5.5 | 53m10 |
| Sn(n,n) | $\sigma_{el}$ | 6.0 | | 1.0 | 53w3 |
| | $d\sigma_{el}/d\Omega$ | graph | | 1.0 | 53w3 |
| Sn(n) | $\sigma_t$ | graph | | 1 - 3.2 | 52m2 |
| | $\sigma_t$ | 4.68 | | 14.1 | 52c1 |
| $Sn^{120}(n,\gamma)$ | $\sigma(27.5^h Sn)$ | 14 | mb | ~1 | 53h11 |
| $Sn^{122}(n,\gamma)$ | $\sigma(40^m Sn)$ | 12 | mb | ~1 | 53h11 |
| $Sn^{124}(n,\gamma)$ | $\sigma(10^d Sn)$ | 4 | mb | ~1 | 53h11 |
| | $\sigma(9.5^m Sn)$ | 15 | mb | ~1 | 53h11 |
| Sb(n) | $\sigma_t$ | graph | | 1 - 3.2 | 52m2 |
| | $\sigma_t$ | 4.71 | | 14.1 | 52c1 |
| $Sb^{121}(n)$ | $\sigma_a$ | 5.7 | | th | 52p1 |
| $Sb^{121}(n,2n)$ | $\sigma(16.6^m Sb)$ | 0.75 | | 14.5 | 53p1 |
| $Sb^{121}(n,\gamma)$ | $\sigma(2.8^d Sb)$ | 90 | mb | ~1 | 53h11 |
| $Sb^{123}(n,2n)$ | $\sigma(2.8^d Sb)$ | 1.2 | | 14.5 | 53p1 |
| Te(n) | $\sigma_t$ | graph | | 0.1 - 3 | 53w2 |
| | $\sigma_t$ | 4.9 | | 14.1 | 52c1 |
| $Te^{128}(n,2n)$ | $\sigma(9.3^h Te)$ | 0.78 | | 14.5 | 53p1 |
| $Te^{130}(n,2n)$ | $\sigma(72^m + 32^d Te)$ | 0.60 | | 14.5 | 53p1 |
| I(n) | $\sigma_t$ | graph | | 5ev - 5kev | 52m4 |
| | $\sigma_t$ | graph | | 1 - 3.2 | 52m2 |
| | $\sigma_t$ | 4.7 | | 14.1 | 52c1 |
| $I^{127}(n,\alpha)$ | $\sigma(21^m Sb)$ | 0.018 | | 14.5 | 53p1 |
| $I^{127}(n,2n)$ | $\sigma(13.0^d I)$ | 1.1 | | 14.5 | 53p1 |
| | | graph | | 12 - 18 | 53m4 |
| $I^{127}(n,p)$ | $\sigma(9.3^h Te)$ | 0.23 | | 14.5 | 53p1 |
| $I^{127}(n,\gamma)$ | $\sigma(25^m I)$ | graph | | 0.25 - 1.6 | 53m4 |
| | $\sigma(25^m I)$ | 105 | mb | ~1 | 53h11 |
| NaI(n) | $\sigma_a$ | 7.4 | | th | 53h7 |
| $Xe^{136}(n,\gamma)$ | $\sigma(3.9^m Xe)$ | 1.0 | mb | ~1 | 53h11 |
| Ba(n) | $\sigma_t$ | graph | | 0.05 - 3.2 | 52m2 |
| | $\sigma_t$ | 5.2 | | 14.1 | 52c1 |
| $Ba^{138}(n,p)$ | $\sigma(33^m Cs)$ | 0.006 | | 14.5 | 53p1 |
| $Ba^{138}(n,\gamma)$ | $\sigma(85^m Ba)$ | 0.074 | | ~ 0.025 | 53k4 |
| | $\sigma(85^m Ba)$ | 2.3 | mb | ~1 | 53h11 |

Neutron Cross Sections - continued

| Reaction | $\sigma$ Type | Value | | Energy | Ref. |
|---|---|---|---|---|---|
| La(n) | $\sigma_s$ coh | 8.7 | | | 53k10 |
| | $\sigma_s$ | 9.3 | | | 53k10 |
| | $\sigma_t$ | 14.3 | | 0.07 ev | 53k10 |
| | $\sigma_t$ | graph | | 0.02 - 3.2 | 52m2 |
| | $\sigma_t$ | 5.2 | | 14.1 | 52c1 |
| $La^{139}(n,p)$ | $\sigma(85^m Ba)$ | 0.006 | | 14.5 | 53p1 |
| $La^{139}(n,\gamma)$ | $\sigma(40^h La)$ | 5.0 | mb | ~1 | 53h11 |
| Ce(n) | $\sigma_s$ coh | 2.2 | | | 53k10 |
| | Low value due to impurities? Value calc. from $Ce^{140}$ and $Ce^{142}$ is 2.7 | | | | |
| | $\sigma_t$ | graph | | 0.02 - 3.2 | 52m2 |
| | $\sigma_t$ | 5.1 | | 14.1 | 52c1 |
| $Ce^{140}(n)$ | $\sigma_s$ coh | 2.8 | | | 53k10 |
| $Ce^{140}(n,\alpha)$ | $\sigma(2.6^m Ba)$ | 0.012 | | 14.5 | 53p1 |
| $Ce^{140}(n,\gamma)$ | $\sigma(28^d Ce)$ | 5.4 | mb | ~1 | 53h11 |
| $Ce^{142}(n)$ | $\sigma_s$ coh | 2.6 | | | 53k10 |
| $Ce^{142}(n,\gamma)$ | $\sigma(33^h Ce)$ | 4.2 | mb | ~1 | 53h11 |
| Pr(n) | $\sigma_t$ | graph | | 0.05 - 3.2 | 52m2 |
| | $\sigma_t$ | 4.9 | | 14.1 | 52c1 |
| $Pr^{141}(n)$ | $\sigma_s$ coh | 2.4 | | | 53k10 |
| | $\sigma_s$ bound | 4.0 | | | 53k10 |
| $Pr^{141}(n,2n)$ | $\sigma(3.6^m Pr)$ | 2.1 | | 14.5 | 53p1 |
| $Pr^{141}(n,\gamma)$ | $\sigma(19^h Pr)$ | 11 | mb | ~1 | 53h11 |
| Nd | $\sigma_s$ coh | 6.5 | | | 53k10 |
| | $\sigma_s$ bound | ~16 | | | 53k10 |
| $Nd^{142}$ | $\sigma_s$ coh | 7.5 | | | 53k10 |
| $Nd^{142}(n)$ | $\sigma_a$ | 18 | | th | 52p1 |
| | $\sigma_a$ | 13 | | pile | 53w4 |
| $Nd^{143}(n)$ | $\sigma_a$ | 290 | | th | 52p1 |
| | $\sigma_a$ | 334 | | pile | 53w4 |
| $Nd^{144}(n)$ | $\sigma_s$ coh | 1.0 | | | 53k10 |
| | $\sigma_a$ | 4.8 | | th | 52p1 |
| | $\sigma_a$ | ~0 | | pile | 53w4 |
| $Nd^{145}(n)$ | $\sigma_a$ | 52 | | th | 52p1 |
| | $\sigma_a$ | 37 | | pile | 53w4 |
| $Nd^{146}(n)$ | $\sigma_s$ coh | 9.5 | | | 53k10 |
| | $\sigma_a$ | 9.8 | | th | 52p1 |
| | $\sigma_a$ | ~4 | | pile | 53w4 |
| $Nd^{146}(n,\gamma)$ | $\sigma(11^d Nd)$ | 40 | mb | ~1 | 53h11 |
| $Nd^{148}(n)$ | $\sigma_a$ | ~3.3 | | th | 52p1 |
| | $\sigma_a$ | ~4 | | pile | 53w4 |
| $Nd^{148}(n,\gamma)$ | $\sigma(1.7^h Nd)$ | 80 | mb | ~1 | 53h11 |
| $Nd^{150}(n)$ | $\sigma_a$ | ~3 | | th | 52p1 |
| | $\sigma_a$ | ~0 | | pile | 53w4 |
| $Sm^{152}(n)$ | $\sigma_s$ coh | ~3 (-) | | | 53k10 |
| $Sm^{152}(n,\alpha)$ | $\sigma(1.7^h Nd)$ | 0.009 | | 14.5 | 53p1 |
| $Sm^{154}(n)$ | $\sigma_s$ coh | ~8 | | | 53k10 |

Neutron Cross Sections - continued

| Reaction | σ Type | Value | | Energy | Ref. |
|---|---|---|---|---|---|
| $Sm^{154}(n,2n)$ | $\sigma(47^h Sm)$ | 0.22 | | 14.5 | 53p1 |
| $Sm_2O_3(n)$ | $\sigma_s/\sigma_a$ | graph | | 0.025 - 0.16 ev | 53b4 |
| Single level indicated | | | | | |
| $Eu_2O_3(n)$ | $\sigma_s/\sigma_a$ | graph | | 0.025 - 0.16 ev | 53b4 |
| $Gd^{160}(n,2n)$ | $\sigma(18.0^h Gd)$ | 1.5 | | 14.5 | 53p1 |
| $Gd_2O_3(n)$ | $\sigma_s/\sigma_a$ | graph | | 0.025 - 0.16 ev | 53b4 |
| Two levels indicated | | | | | |
| $Dy_2O_3(n)$ | $\sigma_s/\sigma_a$ | graph | | 0.025 - 0.13 ev | 53b4 |
| Er(n) | $\sigma_s$ coh | 7.8 | | | 53k10 |
| | $\sigma_s$ bound | ~16 | | | 53k10 |
| | $\sigma_t$ | 138 | | 0.06 ev | 53k10 |
| $Lu^{175}(n,\gamma)$ | $\sigma(3.7^h Lu)$ | 158 | mb | ~1 | 53h11 |
| $Lu^{176}(n,\gamma)$ | $\sigma(6.7^d Lu)$ | 330 | mb | ~1 | 53h11 |
| Hf(n,n) | $\sigma_a$ | 4.7 | | 1.0 | 53w3 |
| | $d\sigma_{el}/d\Omega$ | graph | | 1.0 | 53w3 |
| $Hf^{174}(n)$ | $\sigma_a$ | ~500 | | th | 52p1 |
| $Hf^{176}(n)$ | $\sigma_a$ | ~15 | | th | 52p1 |
| $Hf^{177}(n)$ | $\sigma_a$ | 380 | | th | 52p1 |
| $Hf^{178}(n)$ | $\sigma_a$ | 70 | | th | 52p1 |
| $Hf^{179}(n)$ | $\sigma_a$ | ~50 | | th | 52p1 |
| $Hf^{180}(n)$ | $\sigma_a$ | ~13 | | th | 52p1 |
| Ta(n) | $\sigma_t$ | graph | | 1 - 3.2 | 52m2 |
| | $\sigma_t$ | 5.2 | | 14.1 | 52c1 |
| $Ta^{181}(n,2n)$ | $\sigma(8.0^h Ta)$ | 0.9 | | 14.5 | 53p1 |
| $Ta^{181}(n,\gamma)$ | $\sigma(117^d Ta)$ | 142 | mb | ~1 | 53h11 |
| W(n) | $\sigma_t$ | graph | | 1 - 3.2 | 52m2 |
| | $\sigma_t$ | 5.3 | | 14.1 | 52c1 |
| $W^{186}(n,\gamma)$ | $\sigma(24^h W)$ | 0.42 | | ~ 0.025 | 53k4 |
| | $\sigma(24^h W)$ | 71 | mb | ~1 | 53h11 |
| $Re^{185}(n,\gamma)$ | $\sigma(93^h Re)$ | 180 | mb | ~1 | 53h11 |
| $Re^{187}(n,\gamma)$ | $\sigma(19^h Re)$ | 165 | mb | ~1 | 53h11 |
| Pt(n) | $\sigma_t$ | graph | | 0.1 - 3 | 53w2 |
| | $\sigma_t$ | 5.4 | | 14.1 | 52c1 |
| $Pt^{198}(n,2n)$ | $\sigma(18^h Pt)$ | 3 | | 14.5 | 53p1 |
| $Pt^{198}(n,\gamma)$ | $\sigma(29^m Pt)$ | 64 | mb | ~1 | 53h11 |

Neutron Cross Sections - continued

| Reaction | σ Type | Value | | Energy | Ref. |
|---|---|---|---|---|---|
| Au(n) | $\sigma_a$ | 97.5 | | th | 53c10 |
| Extrapolated value assuming 1/v. $E_n$=0.0035 to 0.00068 ev | | | | | |
| Au(n,<11.5n) | $\sigma_{in}$ | 2.51 | | 14 | 52p2 |
| (n,<2.6n) | | 2.06 | | | |
| (n,<1.4) | | 1.47 | | | |
| Au(n) | $\sigma_t$ | graph | | 0.1-0.7 | 53s4 |
| | $\sigma_t$ | graph | | 0.1 - 3 | 53w2 |
| | $\sigma_t$ | 5.1 | | 14 | 53a1 |
| | $\sigma_t$ | 5.3 | | 14.1 | 52c1 |
| $Au^{197}(n,2n)$ | $\sigma(5.6^d Au)$ | 1.7 | | 14.5 | 53p1 |
| $Au^{197}(n,\gamma)$ | $\sigma(2.7^d Au)$ | 120 | mb | ~1 | 53h11 |
| $Au^{197}(n,n')$ | $\sigma(7.4^s Au)$ | graph | | 0.42-5.5 | 53m10 |
| Hg(n) | $\sigma_t$ | graph | | 3ev - 10kev | 52h5 |
| | $\sigma_t$ | graph | | 0.1 - 3 | 53w2 |
| | $\sigma_t$ | graph | | 0.4- 3.5 | 52j2 |
| | $\sigma_t$ | 5.3 | | 14 | 53a1 |
| | $\sigma_t$ | 5.4 | | 14.1 | 52c1 |
| $Hg^{204}(n,\gamma)$ | $\sigma(5.5^m Hg)$ | 102 | mb | ~1 | 53h11 |
| Tl(n) | $\sigma_t$ | 5.4 | | 14.1 | 52c1 |
| $Tl^{205}(n,p)$ | $\sigma(5.5^m Hg)$ | 0.003 | | 14.5 | 53p1 |
| Pb(n,n) | $d\sigma_s/d\Omega$ | graph | | 0.07 ev | 53m11 |
| | $d\sigma_s/d\Omega$ | graph | | 3.7 | 53w7 |
| | $\sigma_{el}$ | 4.6 | | 1.0 | 53w3 |
| | $d\sigma_{el}/d\Omega$ | graph | | 1.0 | 53w3 |
| Pb(n,<11.5n) | $\sigma_{in}$ | 2.56 | | 14 | 52p2 |
| (n,<2.6n) | | 2.29 | | | |
| (n,<1.4n) | | 0.91 | | | |
| Pb(n,n') | $\sigma$(~3.5 Mev $\gamma$'s) | ~0.3 | | 14 | 53b5 |
| | $\sigma$(~2.5 Mev $\gamma$'s) | ~4 | | 14 | 53b5 |
| | $\sigma$(all $\gamma$'s) | 4.2 | | 14 | 53s8 |
| Pb(n) | $\sigma_t$ | graph | | 0.0013-0.02 ev | 53m11 |
| | $\sigma_t$ | 8.63 | | th | 53w6 |
| | $\sigma_t$ | graph | | 1 - 3.2 | 52m2 |
| | $\sigma_t$ | 7.60 | | 3.7 | 53w7 |
| | $\sigma_t$ | graph | | 3 - 13 | 53n1 |
| | $\sigma_t$ | 5.8 | | 14 | 53a1 |
| | $\sigma_t$ | 5.4 | | 14.1 | 52c1 |
| | $\sigma_t$ | 4.22 | | 55 | 53r2 |
| | $\sigma_t$ | 4.87 | | 85 | 53r2 |
| | $\sigma_t$ | table | | 37 - 153 | 53t2 |
| | $\sigma_t$ | 2.89 | | 400 | 53n2 |
| $Pb^{204}(n)$ | $\sigma_a$ | ~0.9 | | th | 52p1 |
| $Pb^{206}(n)$ | $\sigma_a$ | ~0.1 | | th | 52p1 |
| | $\sigma_t$ | graph | | 1 - 3.2 | 52m2 |
| $Pb^{207}(n)$ | $\sigma_a$ | 0.70 | | th | 52p1 |
| $Pb^{208}(n)$ | $\sigma_a$ | ≤ 0.3 | | th | 52p1 |
| $Pb^{208}(n,p)$ | $\sigma(3.1^m Tl)$ | 0.001 | | 14.5 | 53p1 |
| $Pb^{208}(n,\gamma)$ | $\sigma(3.3^h Pb)$ | 0.002 | | ~1 | 53h11 |

## Neutron Cross Sections - continued

| Reaction | σ Type | Value | Energy | Ref. |
|---|---|---|---|---|
| Bi(n) | $\sigma_a$ | 0.031 | pile | 53i3 |
| Bi(n,n) | $\sigma_{el}$ | 4.8 | 1.0 | 53w3 |
| | $d\sigma_{el}/d\Omega$ | graph | 1.0 | 53w3 |
| Bi(n,<11.5n) | $\sigma_{in}$ | 2.56 | 14 | 52p2 |
| (n,<2.6n) | | 2.28 | | |
| (n,<1.4n) | | 1.03 | | |
| Bi(n) | $\sigma_t$ | graph | 1 - 3.2 | 52m2 |
| | $\sigma_t$ | graph | 3 - 13 | 53n1 |
| | $\sigma_t$ | 5.4 | 14 | 53a1 |
| | $\sigma_t$ | 5.5 | 14.1 | 52c1 |
| $Bi^{209}$(n,α) | $\sigma(4.2^m Tl)$ | 0.001 | 14.5 | 53p1 |
| $Bi^{209}$(n,γ) | $\sigma(5^d Bi)$ | 0.21 | pile | 53i3 |
| (n,γβ) | $\sigma(138^d Po)$ | | | |
| (n,γ) | $\sigma(5^d Bi)$ | 0.0034 | ~1 | 53h11 |
| $Rn^{222}$(n) | $\sigma(11.2^d Ra^{223})$ | 0.7 | pile | 53b9 |
| $Ra^{226}$(n,γ) | $\sigma(42^m Ra^{227})$ | 22 | th ? | 52b4 |
| $Ac^{227}$(n) | $\sigma_a$ | 500 | th | 52p3 |
| Th(n) | $\sigma_t$ | graph | 2ev - 2kev | 52h5 |
| | $\sigma_t$ | graph | 0.1 - 3 | 53w2 |
| | $\sigma_t$ | 6.11 | 13.9 | 50i1 |
| | $\sigma_t$ | 3.23 | 400 | 53n2 |
| $Th^{230}$(n) | $\sigma_a$ | 30 - 60 | pile | 49h1 |
| $Pa^{230}$(n) | $\sigma_a$ | ~1500 | pile | 47g1 |
| $Pa^{231}$(n,γβ⁻) | $\sigma(70^y U)$ | 290 | pile | 53e3 |
| $Pa^{232}$(n,γ) | $\sigma(27.4^d Pa)$ | ~40 | pile | 53e3 |
| U(n) | $\sigma_s$ coh | 9.0 | th | 51s1 |
| | $\sigma_t$ | 9.0 | th | 51s1 |
| | $\sigma_t$ | graph | 3.7 - 800ev | 53h5 |
| | $\sigma_t$ | graph | 3 - 13 | 53n1 |
| | $\sigma_t$ | 5.9 | 14.1 | 52c1 |
| | $\sigma_t$ | 5.7 | 14.1 | 52c1 |
| | $\sigma_t$ | 3.26 | 400 | 53n2 |
| $U^{232}$(n) | $\sigma_a$ | <500 | pile | 53e1 |
| $U^{232}$(n,f) | $\sigma_f$ | ~80 | th | 53e1 |
| $U^{234}$(n,f) | $\sigma_f$ | graph | 0.4-4.0 | 53i4 |


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## GROUND STATE Q'S

| Reaction | Standard | Value | Method | Ref. |
|---|---|---|---|---|
| $H^2(d,n)He^3$ | | + 3.25 ±0.08 | ppl | 53d5 |
| $H^3(p,\gamma)He^4$ | $Li^7(p,\gamma)$ | +19.7 ± 0.4 | scin | 53w5 |
| $H^3(d,n)He^4$ | | +17.7 ±0.3 | ppl | 53r3 |
| $H^3(He^3,p)He^5$ | | +11.18 ± 0.07 | ppl | 53a5 |
| $He^3(He^3,p)Li^5$ | | +10.86 ± 0.15 | ppl | 53a5 |
| $He^5 \longrightarrow \alpha + n$ | | + 0.90 ± 0.07 | ppl | 53a5 |

## Ground State Q's - continued

| Reaction | Standard | Value | Method | Ref. |
|---|---|---|---|---|
| $He^5 \longrightarrow \alpha+n$ | | + 0.95 ±0.07 | range | 53m8 |
| $Li^6(p,\alpha)He^3$ | absolute | + 4.023 ± 0.003 | s | 53c1 |
| $Li^6(d,\alpha)He^4$ | absolute | +22.396 ± 0.012 | s | 53c1 |
| $Li^6(d,\alpha)He^4$ | | + 22.375±0.014 | s | 53p2 |
| $Li^6(d,tp)He^4$ | | + 2.51 ±0.04 | s | 53f5 |
| $Li^6(d,t)Li^5$ | | + 0.9 ±0.1 | s | 53f5 |
| $Li^6(d,p)Li^7$ | absolute | + 5.028 ± 0.003 | s | 53c1 |
| $Li^6(He^3,p)Be^8$ | $H^2(He^3,p)$ | +16.60 ± 0.25 | scin | 53k9 |
| $Li^7(p,\alpha)He^4$ | absolute | +17.344 ± 0.013 | s | 53f7 |
| $Li^7(p,\alpha)He^4$ | absolute | +17.352 ± 0.009 | s | 53c1 |
| $Li^7(p,n)Be^7$ | Na $\gamma$ [Mg(p,p')] | - 1.6464 ±0.0009 | thresh | 53j1 |
| $Li^7(d,\alpha)He^5$ | | +14.2 ±0.1 | ppl | 53c8 |
| $Be^8 \longrightarrow 2\alpha$ | $Li^7(p,n)$ | + 0.0945 ± 0.0014 | EA | 53j2 |
| $Be^9(n,\gamma)Be^{10}$ | absolute | + 6.816±0.006 pair | s | 53k7 |
| $Be^9(p,\alpha)Li^6$ | $Li^7(p,n)$ | + 2.126* ±0.004 | EA | 52c3 |
| $Be^9(p,\alpha)Li^6$ | absolute | + 2.126 ± 0.003 | s | 53c1 |
| $Be^9(p,d)Be^8$ | absolute | + 0.560 ± 0.003 | s | 53c1 |
| $Be^9(d,\alpha)Li^7$ | absolute | + 7.153 ± 0.004 | s | 53c1 |
| $Be^9(d,t)Be^8$ | | + 4.60 ± 0.03 | ppl | 52c2 |
| $B^{10}(n,\alpha)Li^7$ | $Po^{212}$ $\alpha$ | + 2.781 ± 0.025 | pc | 52h7 |
| $B^{10}(p,\alpha)Be^7$ | $Li^7(p,n)$ | + 1.147 ± 0.0025 | EA | 52c3 |
| $B^{10}(p,He^3)Be^8$ | $Li^7(p,n)$ | - 0.536 ± 0.003 | EA | 52c3 |
| $B^{10}(d,\alpha)Be^8$ | | + 17.87 ±0.08 | s | 53c9 |
| $B^{10}(d,\alpha)Be^8$ | $Bi^{212}$ $Po^{212}$ $\alpha$ | +17.91 ±0.06 | ic | 53t3 |
| $B^{11}(p,\alpha)Be^8$ | absolute | + 8.589 ± 0.005 | s | 53c1 |
| $B^{11}(d,p)B^{12}$ | | + 1.140±0.008 | s | 53e4 |
| $C^{12}(d,p)C^{13}$ | absolute | + 2.722 ± 0.004 | s | 53f7 |
| $C^{13}(d,\alpha)B^{11}$ | | + 5.166±0.005 | s | 53p2 |
| $N^{14}(n,\gamma)N^{15}$ | absolute | +10.832±0.008 pair | s | 53k7 |
| $N^{14}(d,p)N^{15}$ | $Po^{212}$ $\alpha$ | + 8.613 ±0.011 | s | 52m5 |
| $N^{14}(d,n)O^{15}$ | | + 5.15 ± 0.16 | ppl | 53e2 |
| $N^{14}(\alpha,p)O^{17}$ | | - 1.16 | ppl | 53h4 |
| $N^{15}(p,\alpha)C^{12}$ | absolute | + 4.962 ± 0.004 | s | 53c1 |
| $O^{16}(d,\alpha)N^{14}$ | absolute | + 3.119 ± 0.005 | s | 53f7 |
| $O^{16}(d,\alpha)N^{14}$ | $Li(p,n)$ | + 3.113 ± 0.0035 | EA | 52c3 |
| $O^{18}(p,\alpha)N^{15}$ | $Be^9(d,\alpha)$ | + 3.96 ± 0.04 | s | 51s2 |
| $F^{19}(\alpha,p)Ne^{22}$ | | + 1.57 | ppl | 52h6 |
| $Ne^{21}(p,n)Na^{21}$ | $F^{19}(p,n)$ | - 3.765 | | 52k1 |

* Supersedes value of 2.123, R.W.Williamson, et al., Phys. Rev. 84, 731(1951).

Ground State Q's – continued

| Reaction | Standard | Value | Method | Ref. |
|---|---|---|---|---|
| $Ne^{21}(d,\alpha)F^{19}$ | $Bi^{212}$ α | + 6.432 ± 0.010 | s | 52m5 |
| $Ne^{21}(d,p)Ne^{22}$ | $Po^{212}$ α | + 8.137 ± 0.011 | s | 52m5 |
| $Ne^{22}(p,n)Na^{22}$ | $F^{19}(p,n)$ | − 3.913 | | 52k1 |
| $Na^{23}(p,\alpha)Ne^{20}$ | $Li^{7}(p,n)$ | + 2.379 ± 0.003 | EA | 53d1 |
| $Na^{23}(d,p)Na^{24}$ | $Bi^{212}$ α | + 4.723 ± 0.008 | s | 52m5 |
| $Na^{23}(d,p)Na^{24}$ | Po α | + 4.731 ± 0.007 | ppl | 52s2 |
| $Na^{23}(\alpha,p)Mg^{26}$ | | + 1.55 | ppl | 52h8 |
| $Mg^{24}(n,\gamma)Mg^{25}$ | absolute | + 7.334±0.007 | pair s | 53k8 |
| $Mg^{24}(p,\gamma)Al^{25}$ | F(p,α) | + 2.1 ± 0.1 | scin | 53c2 |
| $Mg^{24}(d,n)Al^{25}$ | | + 0.07 ± 0.06 | ppl | 53g2 |
| $Mg^{24}(\alpha,p)Al^{27}$ | | − 1.613 ± 0.010 | s | 52k2 |
| $Mg^{26}(n,\gamma)Mg^{27}$ | absolute | + 6.440±0.008 | pair s | 53k8 |
| $Mg^{26}(p,\gamma)Al^{27}$ | F(p,α) | + 8.3 ± 0.4 | scin | 53c2 |
| $Al^{27}(n,\gamma)Al^{28}$ | absolute | + 7.724±0.006 | pair s | 53k7 |
| $Al^{27}(p,\alpha)Mg^{24}$ | $F^{19}(p,\alpha)$ | + 1.61 ± 0.02 | s | 53r5 |
| $Al^{27}(p,\alpha)Mg^{24}$ | $Li^{7}(p,n)$ | + 1.594 ± 0.002 | EA | 53d1 |
| $Al^{27}(p,n)Si^{27}$ | $F^{19}(p,\alpha\gamma)$ | − 5.61 ± 0.01 | thresh | 53k1 |
| $Al^{27}(d,\alpha p)Na^{24}$ | | -10.2 | thresh | 53b13 |
| $Al^{27}(\alpha,p)Si^{30}$ | | + 2.26 ± 0.05 | ppl | 51r1 |
| $Si^{28}(\gamma,n)Si^{27}$ | | -16.9 ±0.2 | thresh | 53s6 |
| $Si^{28}(n,\gamma)Si^{29}$ | absolute | + 8.468±0.008 | pair s | 53k7 |
| $Si^{28}(p,n)P^{28}$ | $Mg^{24}(p,n)$ | -15.1 ±0.5 | thresh | 53g3 |
| $Si^{29}(n,\gamma)Si^{30}$ | absolute | +10.601±0.011 | pair s | 53k7 |
| $S^{32}(p,n)Cl^{32}$ | $Mg^{24}(p,n)$ | -13.9 ±0.5 | thresh | 53g3 |
| $S^{32}(d,n)Cl^{33}$ | | + 0.25 ± 0.07 | ppl | 53m2 |
| $S^{32}(\alpha,p)Cl^{35}$ | | − 2.02 ± 0.11 | ppl | 52f2 |
| Mass $(S^{32})$/Mass $(S^{34})$ | | 1.06242 | Mic | 53b3 |
| $Cl^{35}(n,\alpha)P^{32}$ | | + 1.07 ± 0.15 | ic | 52f2 |
| $Cl^{35}(n,\alpha)P^{32}$ | $Po^{212}\alpha$ | + 0.97 ±0.16 | ic | 53a3 |
| $Cl^{35}(d,p)Cl^{36}$ | | + 6.3 | | 52K3 |
| $A^{36}(n,\alpha)S^{33}$ | | + 2.0 ±0.1 | pc | 53t5 |
| $K^{39}(n,\gamma)K^{40}$ | absolute | + 7.789 ± 0.008 | pair s | 53b16 |
| $K^{39}(d,p)K^{40}$ | Po α | + 5.576 ± 0.010 | s | 53b17 |
| $K^{39}(\alpha,p)Ca^{42}$ | | -0.18 | range | 53s5 |
| $K^{40}(n,\gamma)K^{41}$ | absolute | + 9.39 ± 0.06? $E_\gamma$ (max) | pair s | 53b16 |
| $K^{41}(n,\gamma)K^{42}$ | absolute | + 7.34 ± 0.02 | pair s | 53b16 |
| $K^{41}(\alpha,p)Ca^{44}$ | | +1.20 | range | 53s5 |
| $Ca^{40}(\gamma,n)Ca^{39}$ | | -15.8 ±0.1 | thresh | 53s6 |
| $Ca^{40}(d,p)Ca^{41}$ | $O^{16}(d,p)$ | + 6.14 ±0.05 | ppl | 53h9 |
| $Ca^{48}(p,n)Sc^{48}$ | $F^{19}(p,\alpha\gamma)$ / $Li^{7}(p,n)$ | ⩾-0.64 | thresh | 53t6 |

Ground State Q's – continued

| Reaction | Standard | Value | Method | Ref. |
|---|---|---|---|---|
| $Sc^{45}(n,2n)Sc^{44}$ | | -11.0 ± 0.3 | thresh | 53b14 |
| $Sc^{45}(n,\gamma)Sc^{46}$ | absolute | + 8.85 ± 0.08 | pair s | 53b1 |
| $Ti^{46}(d,p)Ti^{47}$ | $O^{16}(d,p)$ | + 6.45 ± 0.05 | range | 52p4 |
| $Ti^{47}(n,\gamma)Ti^{48}$ | absolute | + 9.39 +2.31? | pair s | 53k2 |
| $Ti^{47}(d,p)Ti^{48}$ | $O^{16}(d,p)$ | + 8.14 ± 0.05 ? | range | 52p4 |
| $Ti^{48}(n,\gamma)Ti^{49}$ | absolute | + 6.76 +1.35? | pair s | 53k2 |
| $Ti^{48}(d,p)Ti^{49}$ | $O^{16}(d,p)$ | + 5.81 ± 0.04 | range | 52p4 |
| $Ti^{49}(n,\gamma)Ti^{50}$ | absolute | + 9.19 +1.58? | pair s | 53k2 |
| $Ti^{49}(d,p)Ti^{50}$ | $O^{16}(d,p)$ | + 8.62 ± 0.05 | range | 52p4 |
| $Ti^{49}(p,n)V^{49}$ | $F^{19}(p,\alpha\gamma)$ / $Li^{7}(p,n)$ | − 1.391±0.005 | thresh | 53t6 |
| $Ti^{50}(d,p)Ti^{51}$ | $O^{16}(d,p)$ | + 4.11 ± 0.07 | range | 52p4 |
| $V^{51}(n,\gamma)V^{52}$ | absolute | + 7.305 ± 0.007 | pair s | 53b1 |
| $V^{51}(n,\gamma)V^{52}$ | Au, Cs / Na γ's | + 7.4 | scin | 53h8 |
| $V^{51}(d,p)V^{52}$ | | + 6.25 | a, pc | 51h1 |
| $V^{51}(d,p)V^{52}$ | | +5.0 | | 53k11 |
| $Cr^{52}(d,p)Cr^{53}$ | | + 5.70 | s | 53m1 |
| $Cr^{52}(n,\gamma)Cr^{53}$ | absolute | + 7.929 ± 0.008 | s | 53k2 |
| $Cr^{53}(n,\gamma)Cr^{54}$ | absolute | + 9.716 ± 0.008 | s | 53k2 |
| $Mn^{55}(n,\gamma)Mn^{56}$ | absolute | + 7.261 ± 0.006 | pair s | 53b1 |
| $Mn^{55}(p,n)Fe^{55}$ | $F^{19}(p,\alpha\gamma)$ / $Li^{7}(p,n)$ | − 1.020±0.005 | thresh | 53t6 |
| $Fe^{54}(n,\gamma)Fe^{55}$ | absolute | + 9.298 ± 0.007 | pair s | 53k2 |
| $Fe^{56}(n,\gamma)Fe^{57}$ | absolute | + 7.639 ± 0.004 (+0, 0.014, or 0.13) | pair s | 53k2 |
| $Fe^{57}(n,\gamma)Fe^{58}$ | absolute | +10.16 ± 0.04 | pair s | 53k2 |
| $Co^{59}(n,\gamma)Co^{60}$ | absolute | + 7.486 ± 0.006 | pair s | 53b1 |
| $Ni^{58}(d,p)Ni^{59}$ | | + 6.77 | ppl | 53m1 |
| $Ni^{58}(n,\gamma)Ni^{59}$ | absolute | + 8.997 ± 0.005 | pair s | 53k2 |
| $Ni^{60}(n,\gamma)Ni^{61}$ | absolute | + 8.532 ± 0.008 | pair s | 53k2 |
| $Cu^{63}(\gamma,n)Cu^{62}$ | Q value masses | -10.61 ±0.05 | thresh | 53b7 |
| $Cu^{63}(n,\gamma)Cu^{64}$ | absolute | + 7.914 ± 0.004 | pair s | 53b1 |
| $Cu^{65}(n,\gamma)Cu^{66}$ | absolute | + 7.634 ± 0.006? See $Cu^{66}$ | pair s | 53b1 |
| $Zn^{64}(p,n)Ga^{64}$ | $Cu^{63}(p,n)$ / $Zn^{66}(p,n)$ | + 8.0 ±0.5 | thresh | 53c7 |
| $Zn^{65}(n,\gamma)Zn^{66}$ | absolute | + 7.876 ± 0.007 | pair s | 53k2 |
| $Zn^{67}(n,\gamma)Zn^{68}$ | absolute | + 9.51 ± 0.03 ? | pair s | 53k2 |
| $Zn^{67}(p,n)Ga^{67}$ | $F^{19}(p,\alpha\gamma)$ / $Li(p,n)$ | − 1.785±0.005 | thresh | 53t6 |
| $Zn^{70}(p,n)Ga^{70}$ | " | − 1.45 ±0.03 | thresh | 53t6 |

Ground State Q's - continued

| Reaction | Standard | Value | Method | Ref. |
|---|---|---|---|---|
| $Ga^{71}(p,n)Ge^{71}$ | $F^{19}(p,\alpha\gamma)$ Li(p,n) | -1.03 ±0.03 | thresh | 53t6 |
| $Ge^{70}(n,2n)Ge^{69}$ | | -11.6 ± 0.3 | thresh | 53b14 |
| $Ge^{73}(p,n)As^{73}$ | " | -1.15 ±0.03 | thresh | 53t6 |
| $As^{75}(p,n)Se^{75}$ | " | -1.652±0.005 | thresh | 53t6 |
| $Sr^{88}(d,p)Sr^{89}$ | $O^{16}(d,p)$ | + 4.18 ±0.08 | ppl | 53h9 |
| $Sr^{88}(d,p)Sr^{89}$ | | + 4.33 ±0.10 | s | 53m1 |
| $Mo^{92}(\gamma,n)Mo^{91}$ | | -13.1 ±0.1 | thresh | 53k3 |
| $Mo^{92}(n,2n)Mo^{91}$ | | -12.34 | thresh | 53b6 |
| $Mo^{100}(\gamma,n)Mo^{99}$ | | - 8.1 | thresh | 53d6 |
| $Ag^{109}(\gamma,n)Ag^{108}$ | Q value masses | - 9.07 ±0.07 | thresh | 53b7 |
| $Ag^{109}(\alpha,2n)In^{111}$ | | -14.3 ±0.2 | thresh | 53b12 |
| $Pb^{206}(d,t)Pb^{205}$ | $Al^{27}(d,p)$ | - 1.8 ±0.1 | range | 53h6 |
| $Pb^{206}(d,p)Pb^{207}$ | $Al^{27}(d,p)$ | + 4.48 ±0.05 | range | 53h6 |
| $Pb^{207}(d,t)Pb^{206}$ | $Al^{27}(d,p)$ | - 0.42 ±0.05 | range | 53h6 |
| $Pb^{207}(d,p)Pb^{208}$ | $Al^{27}(d,p)$ | + 5.14 ±0.05 | range | 53h6 |
| $Pb^{208}(d,t)Pb^{207}$ | $Al^{27}(d,p)$ | - 1.10 ±0.05 | range | 53h6 |
| $Pb^{208}(d,p)Pb^{209}$ | $Al^{27}(d,p)$ | + 1.65 ±0.05 | range | 53h6 |
| $Bi^{209}(d,t)Bi^{208}$ | $Al^{27}(d,p)$ | + 1.17 ± 0.05 g.s.value? | range | 53h6 |
| $Bi^{209}(d,p)Bi^{210}$ | $Al^{27}(d,p)$ | +1.94 ± 0.05 g.s.value? | range | 53h6 |
| $Bi^{209}(d,p)Bi^{210}$ | | +1.94 ± 0.05 g.s.value? | range | 53w8 |


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## PACKING FRACTION DIFFERENCES

Where no superscripts have been used with H, C, and O, the weights of the most abundant isotopes, namely 1, 12, and 16, respectively, are to be understood.

$\Delta f$, in Units $10^{-4}$ amu

| Doublet | $\Delta f$ | Ref. |
|---|---|---|
| $H_2 - D$ | + 7.746 ± 0.004 | 53o1 |
| $He^4 - D_2$ | −64.01 ± 0.02 | 53o1 |
| $B^{10} - Ne^{20}$ | +16.722 ± 0.008 | 53o1 |
| $B^{10}H - B^{11}$ | +10.41 ± 0.01 | 53o1 |
| $B^{10}D - C^{12}$ | +22.51 ± 0.02 | 53o1 |
| $B^{10}F^{19} - C^{13}O^{16}$ | + 4.500 ± 0.005 | 53o1 |
| $B^{10}HF^{19} - B^{11}F^{19}$ | + 3.817 ± 0.005 | 53o1 |
| $B^{11} - Ne^{22}$ | +12.382 ± 0.007 | 53o1 |
| $B^{11}H - C^{12}$ | +14.262 ± 0.005 | 53o1 |
| $B^{11}F^{19} - Si^{30}$ | +11.316 ± 0.007 | 53o1 |
| $C^{12} - D_3$ | +70.50 ± 0.02 | 53o1 |
| $C_2^{12}H_4 - C^{12}O^{16}$ | +12.996 ± 0.002 | 53s3 |
| $C_2^{12}H_4 - C^{12}O^{16}$ | +13.008 ± 0.003 | 53o1 |
| $C^{12}H_4 - O^{16}$ | +22.759 ± 0.005 | 53o1 |
| $C^{12}C^{13}H - C_2^{12}H_3$ | − 1.661 ± 0.004 | 53o1 |
| $C^{13} - C^{12}H$ | − 3.458 ± 0.008 | 53e5 |
| $C^{13}O^{16} - Si^{29}$ | + 7.517 ± 0.006 | 53o1 |
| $C^{13}O^{16} - B^{10}F^{19}$ | − 4.500 ± 0.005 | 53o1 |
| $N^{14} - C^{12}H_2$ | − 8.989 ± 0.004 | 53o1 |
| $N_2^{14} - C_2^{12}H_4$ | − 8.986 ± 0.004 | 53o1 |
| $N_2^{14} - C_2^{12}H_4$ | − 8.982 ± 0.002 | 53s3 |
| $N_2^{14} - C^{12}O^{16}$ | + 4.019 ± 0.003 | 53o1 |
| $N_2^{14} - C^{12}O^{16}$ | + 4.0132 ± 0.0008 | 53s3 |
| $N^{14}O^{16} - C_2^{12}H_6$ | −16.321 ± 0.002 | 53s3 |
| $N^{15} - C^{12}H_3$ | −15.585 ± 0.004 | 53o1 |
| $H_2O^{18} - D_2O^{16}$ | − 4.15 ± 0.01 | 53o1 |
| $B^{10}F^{19} - C^{13}O^{16}$ | + 4.500 ± 0.005 | 53o1 |
| $B^{11}F^{19} - Si^{30}$ | +11.316 ± 0.007 | 53o1 |
| $Ne^{20} - B^{10}$ | −16.722 ± 0.008 | 53o1 |
| $Ne^{20} - D_2O^{16}$ | −15.355 ± 0.006 | 53o1 |
| $Ne^{22} - B^{11}$ | −12.382 ± 0.007 | 53o1 |
| $Al^{27} - C_2^{12}H_3$ | −15.561 ± 0.007 | 53o1 |
| $Si^{28} - C^{12}O^{16}$ | − 6.435 ± 0.005 | 53o1 |

Packing Fraction Differences, $\Delta f$, in Units $10^{-4}$ amu (continued)

| Doublet | $\Delta f$ | Ref. |
|---|---|---|
| $Si^{29} - C^{13}O^{16}$ | − 7.517 ± 0.006 | 53o1 |
| $Si^{30} - B^{11}F^{19}$ | −11.316 ± 0.007 | 53o1 |
| $P^{31}H - S^{32}$ | + 2.969 ± 0.003 | 53o2 |
| $P^{31}H_2 - S^{32}H$ | + 2.876 ± 0.004 | 53o2 |
| $P^{31}H - O_2^{16}$ | − 2.577 ± 0.004 | 53o2 |
| $S^{32} - P^{31}H$ | − 2.969 ± 0.003 | 53o2 |
| $S^{32}H - P^{31}H_2$ | − 2.876 ± 0.004 | 53o2 |
| $S^{32} - O_2^{16}$ | − 5.539 ± 0.003 | 53o1 |
| $S^{32}H_2 - S^{34}$ | + 5.837 ± 0.006 | 53o1 |
| $S^{32}O^{16} - C_4^{12}$ | − 6.900 ± 0.005 | 53o1 |
| $S^{33}H_2 - S^{34}H$ | + 3.250 ± 0.009 | 53o1 |
| $S^{34}H_2 - C_3^{12}$ | − 4.596 ± 0.006 | 53o1 |
| $HCl^{35} - C_3^{12}$ | − 6.479 ± 0.003 | 53o1 |
| $Cl^{37} - C_3^{12}H$ | −11.352 ± 0.004 | 53o1 |
| $HCl^{37} - C_3^{12}H_2$ | −11.053 ± 0.004 | 53o1 |
| $A^{40} - D_2O^{16}$ | −20.959 ± 0.007 | 53o1 |
| $A^{40} - C_3^{12}H_4$ | −17.234 ± 0.007 | 53o1 |
| $A^{40} - C_2O$ | − 8.186 ± 0.005 | 52j1 |
| $K^{40} - C_2O$ | − 7.78 ± 0.02 | 52j1 |
| $Ca^{40} - C_2O$ | − 8.139 ± 0.002 | 52j1 |
| $Ni^{61} - Te^{122}$ | − 3.43 ± 0.05 | 52h4 |
| $Ni^{62} - Te^{124}$ | − 3.71 ± 0.03 | 52h4 |
| $Ni^{64} - Te^{128}$ | − 3.81 ± 0.05 | 52h4 |
| $Cu^{65} - Te^{130}$ | − 3.95 ± 0.03 | 52h4 |
| $Zr^{92} - W^{184}$ | − 7.59 ± 0.02 | 53g1 |
| $Zr^{94} - Os^{188}$ | − 7.59 ± 0.01 | 53g1 |
| $Zr^{96} - Os^{192}$ | − 7.48 ± 0.02 | 53g1 |
| $Mo^{92} - W^{184}$ | − 7.44 ± 0.02 | 53g1 |
| $Mo^{94} - Os^{188}$ | − 7.72 ± 0.02 | 53g1 |
| $Mo^{96} - Os^{192}$ | − 7.86 ± 0.01 | 53g1 |
| $Ru^{96} - Os^{192}$ | − 7.55 ± 0.02 | 53g1 |
| $Ru^{102} - Pb^{204}$ | − 8.02 ± 0.03 | 52h7 |
| $Ru^{104} - Pb^{208}$ | − 7.96 ± 0.01 | 52h7 |

Packing Fraction Differences, Δf, in Units $10^{-4}$ amu (continued)

| Doublet | Δf | Ref. |
|---|---|---|
| $Rh^{103} - Pb^{206}$ | −7.94 ±0.01 | 52h7 |
| $Pd^{102} - Pb^{204}$ | −7.94 ±0.04 | 52h7 |
| $Pd^{102} - C_4H_3$ | −13.933 ±0.008 | 52h3 |
| $Pd^{104} - Pb^{208}$ | −8.05 ±0.01 | 52h7 |
| $Pd^{104} - C_4H_4$ | −15.32 ±0.01 | 52h3 |
| $Pd^{105} - C_8H_9$ | −15.78 ±0.01 | 52h3 |
| $Pd^{106} - C_4H_5$ | −16.57 ±0.02 | 52h3 |
| $Pd^{106} - C_8H_{10}$ | −16.52 ±0.02 | 52h3 |
| $Pd^{108} - C_4H_6$ | −17.64 ±0.01 | 52h3 |
| $Pd^{110} - C_4H_7$ | −18.65 ±0.01 | 52h3 |
| $Cd^{106} - C_4H_5$ | −16.26 ±0.01 | 52h3 |
| $Cd^{108} - C_4H_6$ | −17.58 ±0.01 | 52h3 |
| $Cd^{110} - C_4H_7$ | −18.74 ±0.01 | 52h3 |
| $Cd^{111} - C_8H_{15}$ | −19.203 ±0.007 | 52h3 |
| $Cd^{112} - C_4H_8$ | −19.818 ±0.009 | 52h3 |
| $Cd^{112} - C_8H_{16}$ | −19.860 ±0.008 | 52h3 |
| $Cd^{113} - C_8H_{17}$ | −20.231 ±0.008 | 52h3 |
| $Cd^{114} - C_4H_9$ | −20.82 ±0.01 | 52h3 |
| $Cd^{114} - C_3H_5O$ | −14.44 ±0.01 | 52h3 |
| $Cd^{116} - C_3H_6O$ | −15.41 ±0.01 | 52h3 |
| $In^{113} - C_8H_{17}$ | −20.245 ±0.009 | 52h3 |
| $In^{115} - C_9H_7$ | −13.148 ±0.009 | 52h3 |
| $Sn^{115} - C_9H_7$ | −13.17 ±0.02 | 52h3 |
| $Sn^{116} - C_3H_6O$ | −15.65 ±0.02 | 52h3 |
| $Sn^{116} - C_9H_8$ | −13.83 ±0.01 | 52h3 |
| $Sn^{117} - C_9H_9$ | −14.299 ±0.008 | 52h3 |
| $Sn^{118} - C_3H_7O$ | −16.72 ±0.02 | 52h3 |
| $Sn^{118} - C_9H_{10}$ | −14.94 ±0.02 | 52h3 |
| $Sn^{119} - C_9H_{11}$ | −15.376 ±0.009 | 52h3 |
| $Sn^{120} - C_5$ | − 8.15 ±0.01 | 52h3 |
| $Sn^{122} - C_5H$ | − 9.20 ±0.01 | 52h3 |
| $Sn^{124} - C_5H_2$ | −10.169 ±0.008 | 52h3 |
| $Te^{120} - C_9H_{12}$ | −15.79 ±0.01 | 52h3 |
| $Te^{122} - C_5H$ | − 9.244 ±0.007 | 52h3 |
| $Te^{122} - Ni^{61}$ | + 3.43 ±0.05 | 52h4 |
| $Te^{123} - C_5H$ | + 9.06 ±0.03 | 52h3 |

Packing Fraction Differences, Δf, in Units $10^{-4}$ amu (continued)

| Doublet | Δf | Ref. |
|---|---|---|
| $Te^{124} - C_5H_2$ | −10.340 ±0.008 | 52h3 |
| $Te^{124} - Ni^{62}$ | + 3.71 ±0.03 | 52h4 |
| $Te^{125} - C_5H_2$ | +10.16 ±0.03 | 52h3 |
| $Te^{126} - C_5H_3$ | −11.359 ±0.005 | 52h3 |
| $Te^{128} - C_{10}H_8$ | −12.273 ±0.009 | 52h3 |
| $Te^{128} - Ni^{64}$ | + 3.81 ±0.05 | 52h4 |
| $Te^{130} - Cu^{65}$ | + 3.95 ±0.03 | 52h4 |
| $Te^{130} - C_5H_5$ | −13.180 ±0.006 | 52h3 |
| $I^{127} - C_{10}H_7$ | −11.82 ±0.01 | 52h3 |
| $Xe^{124} - C_5H_2$ | −10.098 ±0.005 | 52h3 |
| $Xe^{126} - C_5H_3$ | −11.31 ±0.01 | 52h3 |
| $Xe^{128} - C_{10}H_8$ | −12.432 ±0.006 | 52h3 |
| $Xe^{129} - C_3H_7$ | −20.12 ±0.01 | 52h3 |
| $Xe^{130} - C_5H_5$ | −13.451 ±0.006 | 52h3 |
| $Xe^{131} - CO_2$ | − 4.94 ±0.03 | 52h3 |
| $Xe^{132} - C_5H_6$ | −14.394 ±0.009 | 52h3 |
| $Xe^{132} - CO_2$ | − 4.95 ±0.01 | 52h3 |
| $Xe^{134} - C_5H_7$ | −15.257 ±0.007 | 52h3 |
| $Xe^{136} - C_5H_8$ | −16.051 ±0.006 | 52h3 |
| $W^{184} - Zr^{92}$ | +7.59 ±0.02 | 53g1 |
| $W^{184} - Mo^{92}$ | +7.44 ±0.02 | 53g1 |
| $Os^{188} - Zr^{94}$ | +7.59 ±0.01 | 53g1 |
| $Os^{188} - Mo^{94}$ | +7.72 ±0.02 | 53g1 |
| $Os^{192} - Zr^{96}$ | +7.48 ±0.02 | 53g1 |
| $Os^{192} - Mo^{96}$ | +7.86 ±0.01 | 53g1 |
| $Os^{192} - Ru^{96}$ | +7.55 ±0.02 | 53g1 |
| $Pb^{204} - Ru^{102}$ | +8.02 ±0.03 | 52h7 |
| $Pb^{204} - Pd^{102}$ | +7.94 ±0.04 | 52h7 |
| $Pb^{206} - Rh^{103}$ | +7.94 ±0.01 | 52h7 |
| $Pb^{208} - Ru^{104}$ | +7.96 ±0.01 | 52h7 |
| $Pb^{208} - Pd^{104}$ | +8.05 ±0.01 | 52h7 |


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